On the U

says that in var
treatment to ar
ent, does not i
So that this tre
patient, besides
of nitrate of si
to recommend i
disease he empl
dition of a ver
the concentrati
ence to the con

An experi
years, in the va
lowing conclusi

1. Ichthyc
as it markedly s
an uncomplicate

2. This tr
ticularly in chil

3. Ichthyc
in a very short

4. Ichthyol is an important remedy in dissipating corneal opacities.—*Aerytl. Rundschau, 1898, viii., 307.*

A

MANUAL

OF

OPHTHALMIC PRACTICE.

BY

HENRY S. SCHELL, M.D.,

SURGEON TO WILLS EYE HOSPITAL AND OPHTHALMIC AND AURAL SURGEON TO THE CHILDREN'S HOSPITAL.

WITH FIFTY-THREE ILLUSTRATIONS.

PHILADELPHIA:

D. G. BRINTON,

115 SOUTH SEVENTH STREET.

1881.

Press of WM. F. FELL & Co.,
1220-24 Sansom Street,
Philadelphia.

LIST OF ILLUSTRATIONS.

CONTENTS.

PREFACE.

The object of the writer, in the following pages, has been to state briefly the generally accepted principles of ophthalmology, and to describe those methods of treatment upon which he has become accustomed to rely, from personal experience of their value. The small size of the book has restricted allusions to authorities, to the history of the science, or to any other subject than those mentioned above. Such of the illustrations as are not original have been reproduced from Landolt on the Examination of the Eyes; from Gray's Anatomy, and from the treatises of Wells and Stellwag. Colored lithographs of the fundus oculi, or of the external appearances in disease, are of little or no value unless done in the best manner, and the cost of such work has prevented its introduction. A sheet of test types, after those of Snellen, is appended. It should be removed and pasted on a card, for use in the consulting room.

H. H. S.

1802 CHESTNUT ST.,
PHILADELPHIA, PA., JULY, 1881.

A MANUAL

OF

OPHTHALMIC PRACTICE.

CHAPTER I.

ANATOMY AND PHYSIOLOGY OF THE EYE.

THE EYEBALL, which is globular in form and about seven-eighths of an inch in diameter, has on its anterior aspect, and occupying about one-sixth of its circumference, the segment of a smaller sphere which projects about a line beyond the larger circle. The anterior segment is formed by the Cornea, the remainder by the Sclerotic. These are the firm, outer tunics of the eye. Next within the sclerotic lies the Choroid, and within this the Retina enclosing the Vitreous Humor. Within the cornea is the Aqueous Humor, limited posteriorly by the Crystalline Lens.

The *Sclerotic* (Fig. 1) is a dense, white, fibrous membrane, thicker behind than in front. It gives form and support to the delicate interior structures of the eye, affords points of insertion for its muscles and allows entrance or exit to necessary nerves and vessels. The opening which gives passage to the optic nerve is partly closed by a perforated membrane (*lamina cribrosa*) the minute orifices of

which transmit the nervous filaments. A larger orifice in the centre, the *porus opticus*, admits the *arteria centralis retinæ*, and the retinal veins.

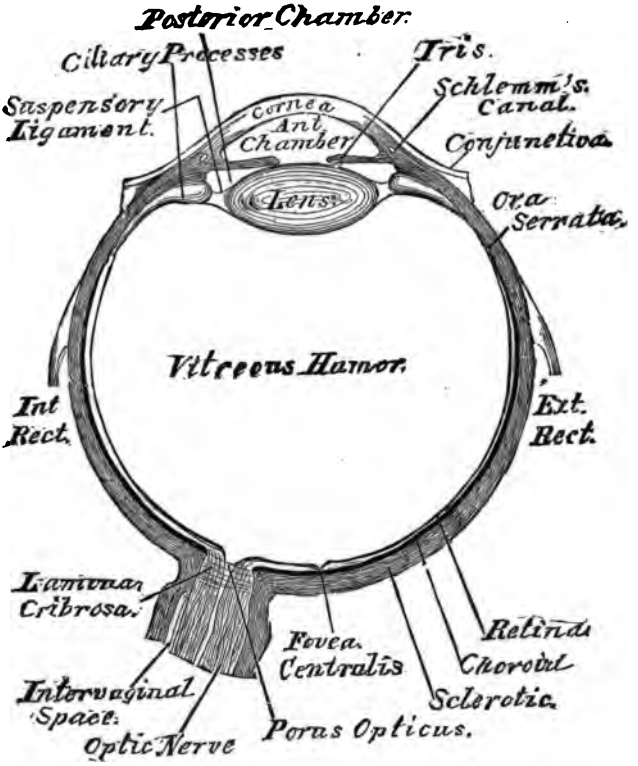

FIG. 1.—Horizontal Section of the Right Eye.

The *Cornea* is a continuation of the sclerotic, but so modified in structure as to be perfectly colorless and transparent. It consists of five layers; a thick central layer, the

cornea proper; in front and behind this the anterior and posterior elastic laminæ; on the outer surface the conjunctival epithelium, and on the inner the lining membrane or membrane of Descemet. The cornea proper is composed of sixty or more parallel laminæ united at frequent intervals. The cornea is non-vascular and is nourished by endosmose. Its nervous supply is abundant and is derived from the ciliary nerves.

The *Choroid* is a thin, dark brown membrane composed almost entirely of blood vessels. It nourishes the vitreous and lens. It is in contact externally with the sclerotic, internally with the retina, and is composed of three layers. The external of these consists of branches of the ciliary arteries and curved veins, called the *venæ vorticosæ*. The middle layer consists of a fine capillary plexus. The internal belongs physiologically to the retina and is a single layer of hexagonal pavement cells loaded with pigment granules. In albinos these cells contain no pigment. At the anterior margin of the choroid the middle and internal layers are arranged in a circle of radiating folds, sixty or more in number, known as the *ciliary processes*, which surround the margin of the lens.

The *Iris* is that circular membrane in the front part of the eye which is variously colored in different individuals. Its circumference is connected with the choroid. The circular aperture in its centre is the *pupil*. The iris is made up of circular and radiating involuntary muscular fibres lodged in a fibrous stroma. The circular fibres contract, the radiating dilate the pupil. The back of the iris is covered with a layer of dark brown pigment cells, which is continu-

ous with the pigment layer of the ciliary processes. The pupillary margin of the iris is in contact with the lens. In the fœtus the pupil is closed by the *membrana pupillaris*, which sometimes remains in after life, to the detriment of vision.

The *Ciliary Ligament* is the ring of fibres which joins the iris, cornea and sclerotic. In it is the minute sinus known as *Schlemm's Canal.*

The *Ciliary Muscle*, the muscle of accommodation, is a circular band of involuntary muscular fibres situated behind the iris at the outer surface of the ciliary processes. It is composed of circular and meridional fibres.

The *Retina* is the soft, transparent membrane which receives the images of external objects. It is continuous with the optic nerve behind and extends forward to the ciliary processes where it terminates by a jagged margin, the *ora serrata.* A little to the outer side of the centre of the posterior part of the eye the retina exhibits a yellow spot, the *macula lutea*, in the centre of which is a depression, the *fovea centralis.* For practical purposes the retina may be considered as made up of three layers. The external of these is composed of rods and cones, which are finest and most closely packed at the macula. They are arranged vertically to the layer of hexagonal cells of the choroid with which they are in contact. The rod and cone layer is of a delicate rose color, which fades at once upon exposure to light, and is derived from a substance, the *retinal red*, secreted by the pavement epithelium. It is probable that the act of vision depends upon the chemical stimulus derived from the decomposition of the retinal red, within the rods, by the

light which forms the pictures of external objects. The internal layer of the retina is composed of the radiating filaments of the optic nerve. The middle layer, or layers, consists of ganglion cells, granules and fibres which connect the percipient elements with the conducting filaments. The retina is supplied with blood by the central artery and vein.

The *Optic Nerve* penetrates the sclerotic about one-tenth of an inch to the nasal side of the fovea centralis, passing through the lamina cribrosa. The nerve is encased in a dense fibrous sheath, continuous with the sclerotic in one direction and with the dura mater in the other. There is also a delicate inner sheath derived from the pia mater. Between these lie a still more delicate membrane, continuous with the arachnoid, and in its interstices is formed the so-called *inter-vaginal space*, which is continuous with the sub-arachnoidal cavity of the cranium.

The *Vitreous Humor* fills the concavity of the retina. It consists of an albuminous fluid enclosed in a delicate membrane, the *hyaloid.*

The *Aqueous Humor* lies in the concavity of the cornea, filling the anterior and posterior chambers. These are separated by the iris only and communicate freely through the pupil.

The *Crystalline Lens* is placed between the aqueous and the vitreous. It is enclosed in a special *Capsule*, an elastic and brittle membrane. The lens is kept in position by the *suspensory ligament*, a delicate, transparent structure which extends from the ora serrata, lining the inner surface of the ciliary processes, to the lens capsule. The lens is pellucid,

more convex posteriorly than anteriorly, measures one-third of an inch in diameter, and a quarter of an inch in thickness. It consists of concentric layers which are softer as the distance increases from the comparatively firm nucleus. The hardness of the lens increases in proportion to the age of the individual, the senile lens being of an amber color, somewhat flattened and of impaired translucency.

The *Capsule of Tenon* is a loosely-fitting fibrous sheath which forms a sort of socket for the eyeball. It is attached to the sclerotic in front, a few lines from the cornea, is perforated for the ocular muscles and surrounds the nerve as far back as the apex of the orbit.

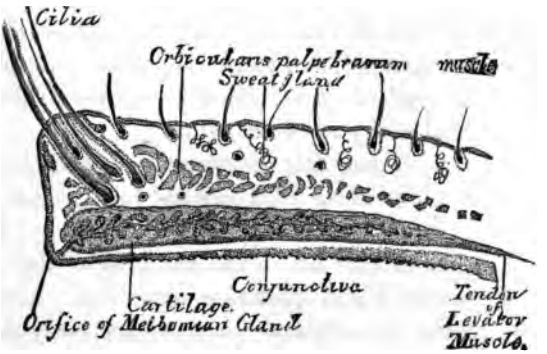

Fig. 2.—Section of the Upper Eyelid.

The Eyelids (Fig. 2) are necessary for the protection of the eyeball. The basis of their structure is the *tarsal cartilage*, which lies close to the conjunctiva and is a thin plate about an inch long, one-third of an inch wide (narrower in the lower lid) and somewhat crescentic in form.

Superiorly the cartilage of the upper lid dwindles to a thin edge, which is continuous with the tendon of the *levator palpebræ superioris*. The angles where the lids join are called *Canthi*. At the inner canthus there is in both lids a small orifice, the *punctum lachrymale*, which is the commencement of the lachrymal canal. The eyelashes (*cilia*) are inserted into the outer angle of the free edge of the lids. The palpebral portion of the orbicularis muscle over-

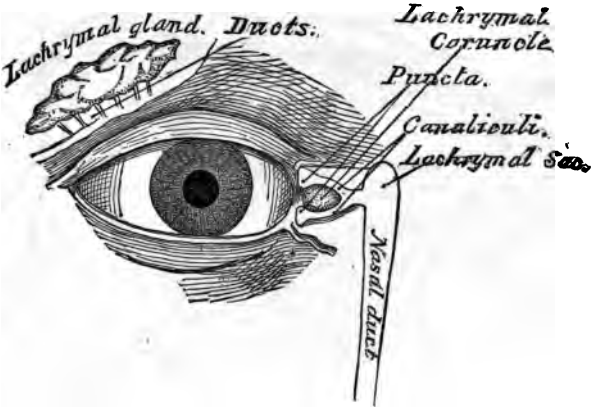

FIG. 3.—The Lachrymal Apparatus.

lies the cartilage. The *Meibomian glands* are imbedded in the conjunctival surface of the cartilages, and their secretion lubricates the edges of the lids.

THE CONJUNCTIVA is the mucous membrane of the eye. It lines the lids and is reflected over the front of the ball. It is firmly attached to the tarsal cartilages, but loosely to the sclerotic. The *lachrymal caruncle* is the small, reddish body, between the lids, at the inner canthus.

The *Lachrymal Gland* (Fig. 3) is lodged in a depression of the bone just within the upper and outer angle of the orbit, and secretes the tears. These are carried off by the *lachrymal canals*, which commence at the *puncta*, pass toward the nose and empty into the *lachrymal sac*. This is continuous with the *nasal duct* which extends to the inferior meatus of the nose.

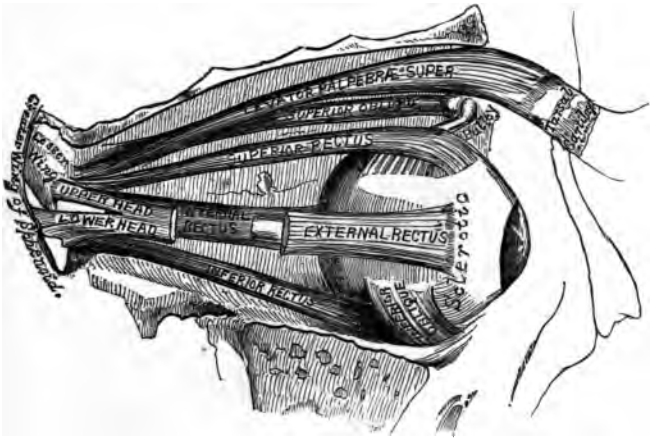

FIG. 4.—Muscles of the Eyeball.

The eyeball is suspended in the orbital cavity, in a bed of cellular tissue, well supplied with fat, by means of six muscles (Fig. 4), the four *recti*—*superior*, *inferior*, *internal* and *external*—and the *superior* and *inferior oblique*. The first five arise at the apex of the orbit. The recti diverge to embrace the ball, pass through the capsule of Tenon, and are inserted into the sclerotic a few lines behind the cornea. The superior oblique passes through the pulley at the inner

and upper angle of the orbit, and, turning outward and backward, is inserted on the outer side of the ball, behind the equator. The inferior oblique arises from the inner and lower angle of the orbit, and is inserted on the outer side of the ball, opposite the superior oblique, with the external rectus lying between them.

For convenience of description the centre of the cornea is called the anterior pole of the eye, the centre of the back

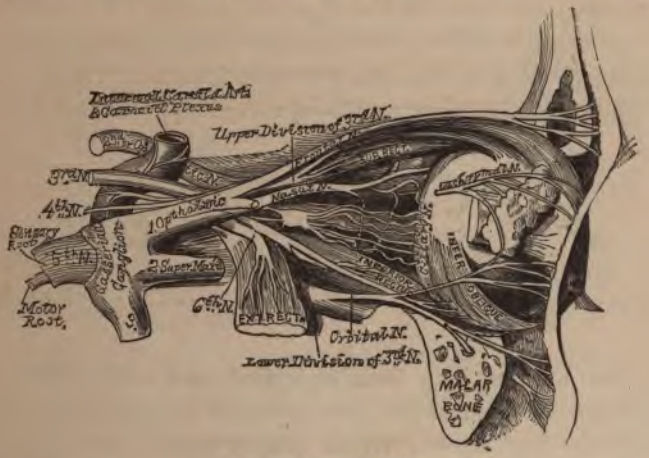

FIG. 5.—Nerves of the Eye.

of the eye the posterior pole, a line passing through these poles the optic axis, and a circle passing round the eye midway between the poles the equator. The visual axis, a line drawn from the fovea centralis to the object looked at, passes through the cornea a little to the nasal side of the optic axis.

The NERVES OF THE EYE (Fig. 5) are, in addition to

the optic, the third, fourth, first division of the fifth and the sixth. *The third* is a motor nerve, and supplies the superior, inferior and internal recti, the inferior oblique, the levator palpebræ and the ciliary muscles, together with the circular fibres of the iris. It furnishes one root to the ciliary ganglion. The *fourth* nerve supplies the superior oblique, and the *sixth* the external rectus. The *fifth* sends sensory branches to the lids and conjunctiva and a root to the ciliary ganglion, also two or three long ciliary nerves. The *ciliary ganglion* sends off ten or twelve *short ciliary* nerves which, together with the *long ciliary* nerves, form a plexus which supplies the iris, ciliary muscle, cornea and blood vessels.

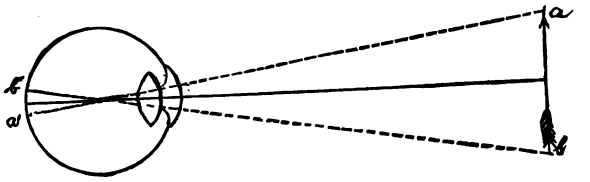

FIG. 6.

The eye has long been compared to a camera which forms, on a screen at the back, inverted images of external objects. That these inverted images should nevertheless convey to the brain the impression of objects in their actual positions is quite explicable when the structure of the retina is taken into consideration. The eye is composed of a multitude of eyes, viz.: the rods and cones of the outer layer of the retina, and each rod or cone is (so far as perception is concerned) a separate and distinct eye, which looks only in the direction of the normal of the curve of the eyeball at that point. Hence the cone at a' (Fig. 6) can see nothing

but the point of the arrow at *a*, and the cone at *b'* sees only the end of the shaft at *b*, both in their actual positions, and so with every intermediate part of the arrow.

Binocular Vision, or the fact that, with two eyes, we have single sight, may be explained in a similar manner. It is known that images of an object must be received on symmetrical portions of the two retinas in order to avoid diplopia. Now these symmetrical parts probably

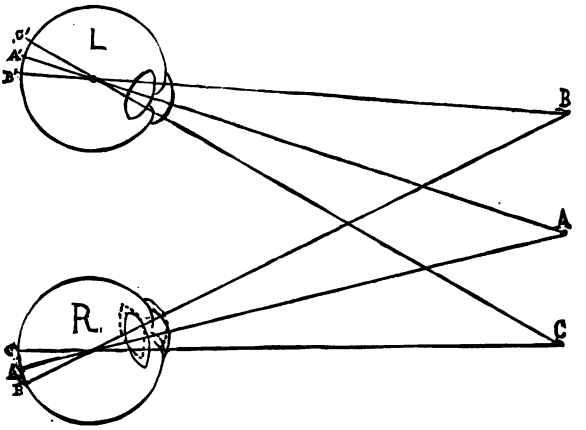

FIG. 7.

contain cones the sensations of which are centrally associated, in the brain. Let L and R (Fig. 7) be the two eyes directed to the object A. The images are received by the associated cones A′ A″ at the fovea centralis. In the same way B and C are depicted on associated cones at B′ B″ and C′ C″ and are perceived as single objects. But suppose the eye R to be rotated a little inward, as indicated

by the dotted lines representing the change in the position of the cornea and lens, so that B comes in the line of the visual axis, then the cone A″ would change its position to point marked B″ and the cone C″ would be shifted so as to receive the image of A. But the two cones, A′ in L and C″ in R, not being associated, and yet receiving the same image, double vision necessarily follows.

The normal or emmetropic eye is one which, in a state of rest, is accurately focused for objects at an infinite distance (Fig. 8). The function of *accommodation* enables the

Fig. 8.

eye to focus near objects distinctly. This is accomplished by the crystalline lens increasing in convexity (Fig. 9), mostly on the anterior surface, and becoming thereby of shorter focus. The lens is very elastic and has constantly a tendency to assume a rounder shape. It is restrained from doing this by the tension of the suspensory ligament, acting upon the capsule. In the act of looking at a near object the ciliary muscle contracts, relaxes the suspensory ligament and capsule, and the resiliency of the lens causes it to assume the proper convexity. This elasticity diminishes, with corresponding diminution of the accommodation,

as life advances, so that after the age of forty-five it is difficult to focus the eye for fine print.

The *field of vision* of each eye extends from the point of fixation about 90° outward, 40° inward, 50° upward and 60° downward. At the point of fixation only, however, is the vision distinct; and accuracy is limited to a circle of less than a quarter of an inch in diameter, at the distance of a yard. This is called *direct* vision, and the imperfect sight characteristic of the rest of the field is known as *indirect* vision. Normal *acuteness of vision* requires that an object at the point of fixation should subtend a visual angle of one minute, in order to be distinctly defined.

FIG. 9.—The changes in accommodation are shown by the dotted lines.

Over the entrance of the optic nerve the layer of rods and cones is absent from the retina, and there is here, consequently, a *blind spot* in the field. This is readily shown by making two black dots, the size of a pea, about four or five inches apart horizontally, on a piece of paper. Then, closing the left eye and looking with the right at the left hand dot, at the same

time moving the paper to and from the eye, a point will soon be found where the right hand dot will disappear.

The *field for colors* (Fig. 10) diminishes in size as we proceed from blue, through yellow, orange and red, to green.

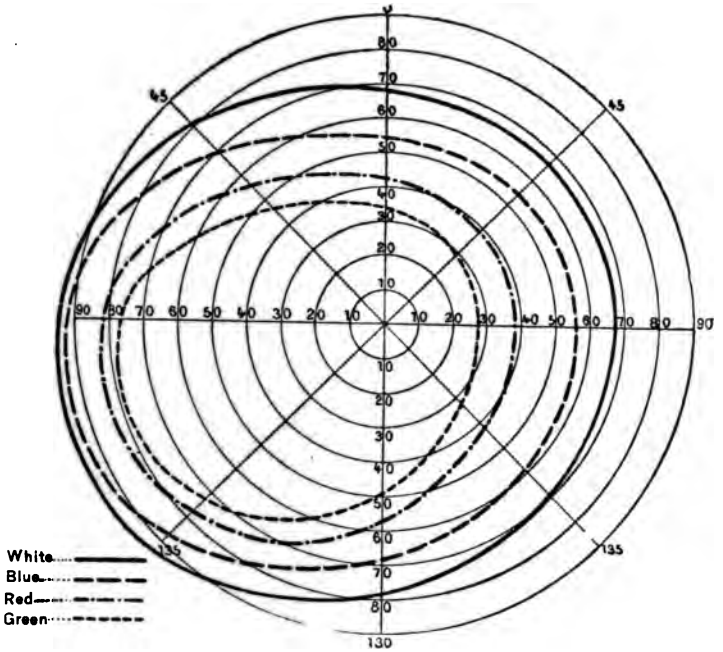

FIG. 10.—Color Fields of Vision.

CHAPTER II.

AFFECTIONS OF THE EYELIDS.

BLEPHARITIS is a chronic inflammation of all the tissues of the lids. It usually commences at the free edge, involving the follicles of the cilia only, and, in this stage, is known as *Blepharitis Marginalis*. This begins with the appearance of a few hard crusts, at isolated positions among the cilia, glueing the roots of several of them together. Such crusts defy removal by ordinary washing in cold water, but when detached, expose reddened surfaces or ulcers. As the disease becomes aggravated, the inflammation involves all the follicles of the cilia, the edge of the lid becomes thickened, many of the lashes fall out, and the crusts extend the entire length of the palpebral opening. If not checked by proper treatment the cellular tissue of the lid becomes affected, and, contracting, draws the free edge away from the ball, the punctum lachrymalis is no longer in position to carry off the tears, which accumulate and mingle with the inflammatory products, producing additional irritation. This may go on until the edges of the lids become somewhat everted, rounded off and bare of cilia; the orifices of the meibomian glands are no longer visible, and the puncta are closed; or there may be fully developed ectropium. The disease is now practically incurable.

Treatment.—The first step consists in getting rid of the crusts. This may be accomplished by a free application of cosmoline or sweet oil at night, and the use of warm water in the morning. If the crusts are very hard, an alkaline solution may be used instead of mere water, and bicarbonate of sodium, gr. viij to water, f℥j, answers well for the purpose. After the edges of the lids are thoroughly cleansed, an ointment composed of yellow oxide of mercury, gr.j, cosmoline, ℥j, may be gently rubbed in among the roots of the lashes, morning and evening. The red oxide, in the same proportion, is often used, but is somewhat more irritating. Every application must be preceded by a thorough removal of the scabs. If the affection does not yield in a week or so, daily pencilings of the edges of the lids with a solution of nitrate of silver, ten grains to the fluidounce of water, should be employed. The use of the ointment should be kept up for a month after the disease is apparently cured, for it still lingers in the depths of the hair follicles, ready to return at the least relaxation of vigilance. If the edges of the lids are much thickened and the cilia gone, careful painting on alternate days, with the tincture of iodine, may be used. If the punctum is everted, the canaliculus should be slit, to give exit to the tears. Other astringents are useful beside those recommended. Dilute white precipitate ointment, tar ointment, oxide of zinc ointment, solution of sugar of lead, etc., may be used as alternatives if desired. When the entire lids become involved, tumid, red and painful, a small poultice of ground slippery elm bark, applied over night, gives great relief.

HORDEOLUM or STYE is an inflammation of one or more of the sebaceous follicles at the roots of the cilia, and, owing to the dense character of the connective tissue at the free edge of the lid and the constant motion of the parts, the swelling, which of necessity follows, is accompanied by an unusual amount of pain. The pimple suppurates in a few days and gets well, but often with the permanent loss of several cilia at the point of disease.

Treatment.—The affection usually occurs in persons who are suffering from constipation or some general derangement of the system, and these conditions must be treated. If the stye be seen sufficiently early, it may often be aborted by keeping the part constantly anointed with cosmoline or vaseline, which penetrates the follicle and dissolves the hardened secretion. If improvement does not result in a day, the eyelash which is most involved should be pulled out, and the point of a cone of lunar caustic applied to the spot. If this fail, recourse must be had to a slippery-elm poultice and early puncture of the pustule.

Obstruction of the orifice of a *sweat gland* sometimes results in the formation of a transparent vesicle at the edge of the lid. It merely requires puncture of the cuticle.

CHALAZION is the result of an obstruction of the duct of a Meibomian gland. It appears as a small tumor in the substance of the lid. The skin is freely movable over the tumor, unless it becomes inflamed, when the parts are sometimes adherent and the gland suppurates and bursts on the conjunctival surface. This usually results in a cure, but granulations often sprout through the opening of the cyst, and are long a source of much irritation.

Treatment.—In nearly all cases the cyst can be most readily attacked from the inner side of the lid. If the upper lid is to be everted, the patient must look down, while the surgeon, by means of the cilia, pulls the lid gently away from the ball and somewhat upward, at the same time pressing down the upper border of the tarsal cartilage with a small pencil or probe. The lower lid usually needs merely to be pulled downward by the finger on the skin below the cilia, while the patient looks upward; or a fold of skin may be pushed behind the cartilage with the probe, if necessary. The lids may be retained everted by the tips of the fingers pressed against the free borders. The conjunctiva covering the gland will be found to be thin, and the tumor should be slit open vertically, from one end to the other, with a Beer's knife (Fig. 11). The gelatinous contents should be evacuated with a small scoop, which may be made with sharp edges (Fig. 12), so as to scratch away the walls of the cyst. If this is done thoroughly, the tumor will not return. If the cyst is large it is well to cauterize the interior with nitrate of silver. If the gland has already burst when the lid is first examined, any projecting granulations should be snipped off with scissors, and the remains of the cyst slit up and scooped out as described.

FIG. 11.—Beer's Knife.

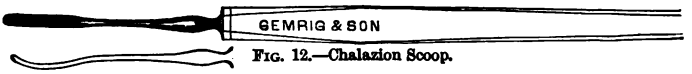

FIG. 12.—Chalazion Scoop.

In some cases the retained secretion of the Meibomian glands becomes *calcareous*, forming, just under the conjunc-

tiva, *concretions*, which are excessively irritating and keep up inflammation of the opposing surfaces. The glands should be slit up and scooped out, as for chalazion.

Eczema, syphilitic ulcer, lupus, epithelioma, nævus and *warts* of the lids do not differ from the same affections in other parts of the body, but, in consideration of the important structures involved, should receive early and efficient treatment or removal by operation.

Erysipelas of the lids often occurs primarily, or the disease may spread from contiguous portions of the face. Owing to the laxity of the cellular tissue, great swelling, with closure of the eyes, ensues. Pus may form beneath the skin, or sloughing may take place and the contraction of consequent cicatrices produce ectropium.

ABSCESS not uncommonly forms in the lids of children. It should be opened in the line of the fibres of the orbicularis.

CONTUSIONS cause much swelling of the lids and discolorization from the settling of blood in the loose cellular tissue. Such a *black eye* may be disguised by the skillful application of paint, if especially desirable for cosmetic reasons; or, the use of a lotion of ammonium chloride, one part to ten of water, will aid the absorption of the effusion. Contusions about the lids are sometimes followed by paralysis of the levator palpebræ, and even by loss of sight, a reflex effect from injury to the fifth nerve.

BURNS often result in sloughing of lax skin, and the contraction of consequent cicatrices produces ectropium or other malposition of the lids. The ordinary remedies for burns are applicable here as elsewhere, provided they can

be kept from getting into the conjunctival sac, but the liberal use of cosmoline probably produces the quickest and best results. If the cuticle is not destroyed, the constant application of cold water will best relieve pain. If the edges of the lids are affected, they will tend to grow together, especially at the canthi, and great care must be taken to separate them frequently.

WOUNDS of the lids should be cleansed of blood clots and other foreign bodies, and carefully united at once by fine sutures, which should include the tarsal cartilage if necessary. The orbicularis and other muscles tend to draw the edges apart, and if a nice adjustment is not made there will result a disfigurement which will require an operation for its relief. Sutures to the lids are best applied by means of very fine, curved needles, not more than three-quarters of an inch in length, carrying the finest sewing silk and used by means of any good needle holder.

XANTHELASMA is an affection in which yellow, slightly raised patches appear upon the lids, especially near the inner canthus. It consists in a deposit of fat cells in the skin, just beneath the cuticle, and is supposed to depend upon disease of the liver.

CONGENITAL CYSTS, containing hair, sebaceous matter, etc., occasionally occur in the lids. In removing them the sac must be carefully dissected out, to prevent a return.

PTOSIS, or falling of the upper lid, may be due to paralysis of the third nerve, to deficient power of the levator palpebræ, to the effect of disease in making the lid too heavy for the muscle, or to adhesions, 1. When ptosis is a symptom of paralysis of the oculo-motor, the other muscles

supplied by that nerve will be affected. The ball is turned outward, and if the lid be raised the patient will suffer from double vision. 2. When the levator only is defective in power, the defect may be of congenital origin, reflex from injury of the fifth nerve or the result of a wound. Both this and the preceding class, however, will be further considered in the chapter on affections of the muscles and nerves.

3. Unusual weight of the lid is generally owing to blepharitis, erysipelas, abscess, conjunctivitis, tumors, etc., and can be relieved by the successful treatment of those disorders. In old persons there sometimes occurs a relaxed condition of the skin and subcutaneous connective tissue, which causes a fold of integument to hang down over the free border of the lid. This may sometimes be relieved by the removal of a crescentic piece of skin, parallel to the free border, and by bringing the wound together with sutures. Sufficient skin should be taken away to make the surface tense when the lids are closed. In more aggravated cases, or when the foregoing operation fails, a portion of the orbicularis corresponding to the wound, or even a wider piece, must be removed. In all such instances very much, of course, must depend upon the judgment and experience of the operator as to the success of the result. In some instances, especially in young women, a deposit of fat occurs in the substance of the lid, between the muscle and the cartilage, in sufficient quantity to produce disfigurement and to render the levator almost unable to uncover the pupil. A careful dissection of the adipose mass from its bed and as far back as the edge of the orbit, or even a little beyond,

together with the removal of a crescentic strip of skin, gives excellent results. A probe-pointed pair of scissors is the most convenient instrument for incising the integument of the lids. The point should be introduced through a puncture, and may then readily be made to slide along in any desired direction in the loose cellular tissue.

ENTROPIUM, or turning in of the lid upon the ball, occurs in very different degrees. What may be considered as the lightest form of the affection is that which is known as *Trichiasis*. This is a partial or complete change of the direction of the cilia, so that these project against the cornea and conjunctiva, keeping the eye irritable and causing intractable ulcers of the cornea. When a few only of the lashes turn in they are generally at the middle or outer third of the lid. These *wild hairs* are often very fine and colorless, are scarcely visible without the aid of a lens, and result from disordered nutrition of the tarsal border consequent upon blepharitis or conjunctivitis. A more aggravated form results from trachoma or granular lids. Many of the cilia, the whole length of the tarsal border, are diverted from their normal direction. If the lid be everted, its conjunctival surface will be found seamed with white bands of cicatricial tissue which draw the tarsal cartilage into an abnormally concave shape, and render it, at the same time, hard and inelastic. This condition causes the free edge of the lid to turn inward and present itself against the ball. The lower lid sometimes, after operations, especially in old people of lax tissue, turns completely over, presenting its outer surface to the cornea. This is the result of spasmodic action of the orbicularis.

Treatment.—Wild hairs may be pulled out with the cilia forceps. Simple as it may seem this is an instrument which it is difficult to obtain well and properly made. The jaws should be devoid of teeth, with opposing surfaces neither so rough as to break the hair, nor so smooth as to let it slip, nor so sharp at the edge as to cut it off and let the root remain. They should fit together accurately and should not spread apart at the tips when the forceps is tightly grasped by the fingers in the act of pulling a hair. It is well to aid the vision with a strong lens, when extracting errant cilia, otherwise the most exasperating may remain untouched. To prevent a return of the hair, the empty follicle may be cauterized with a hot needle, a difficult operation, best done under ether. Or, nitric acid may be applied to it, by means of a very sharp point of hard wood. This is more readily done, and is often effectual. If one only or two conspicuous lashes turn in, their direction may often be improved by a little operation known as *reposito ciliorum.* Both ends of a fine thread are brought through the eye of a delicate needle, which is made to puncture the free edge of the lid, close outside the root of the offending eyelash, and to emerge on the skin at one or two millimetres from the border. The looped end of the thread is placed carefully around the hair, which is then, by this means, dragged through the puncture. When a small group of cilia are at fault, their roots may be dissected out with the point of a Beer's knife. A Snellen's forceps (Fig. 13) should be adjusted to the lid and screwed down until the skin is blanched, to prevent blood from obscuring the operation. Two parallel incisions should be

made on the free edge of the lid, including the roots of the lashes, and penetrating to the depth of about a quarter of an inch. A short vertical incision on the face of the lid, starting from its border, allows the loosened piece to be removed. The results of this procedure are, at first, excellent; but in the course of a few months the cilia bordering the bare spot, and which before were in good position, sometimes turn awry, and plague the sensitive cornea or conjunctiva. A plan has been recommended, to get rid of a group of aberrent cilia, by means of a silk ligature, introduced so as to include them, and tightly tied. This, however, creates great inflammation and pain, and the results are no better than before.

Fig. 13.—Snellen's Forceps.

If the cilia along the whole length of the lid are involved, it will often be found that the palpebral fissure is contracted, especially at the outer corner. In this case, the operation of *Canthoplasty* will frequently afford relief. The external canthus is best enlarged by means of a curved bistoury, which is inserted into the conjunctival sac, pushed horizontally outward to the edge of the orbit, in the line of the palpebral commissure, and made to cut its way out through conjunctiva, skin, and intervening tissues. To make the relaxing effects of this incision permanent, the skin and conjunctiva must be united by three sutures, one at the outer angle, and the other two midway on each lip of the wound.

If Canthoplasty alone should not be effectual, as it probably will not if the tarsal cartilage is very much incurved, recourse may be had to the *operation of Jäsche* and *Arlt.* In this procedure the ball should be protected by means of a horn spatula, placed under the lid and held steadily by an assistant. An incision is then made along the whole length of the free edge, close behind the cilia, great care being taken that none escape. This cut should penetrate to the depth of a quarter of an inch. A second incision, of equal length with the first, is then made on the outer face of the lid, about one-eighth of an inch from the border. By this means, the bridge of skin containing the roots of the cilia is freed, except from its attachments at each end. A crescentic slip of skin is now removed above, and the bridge carried up and united by sutures to the integument beyond. Although this operation is much practiced, I have not found its results lasting. Attempts have been made to improve it, by cutting out a slip of the muscle and making a groove through almost the entire thickness of the cartilage, at the line of the second incision. But I have been most successful by dissecting up the edge of the orbicularis and shaving off, with a scalpel, all of the thicker and most convex portions of the cartilage, until that which remains is soft and pliable. All this is very troublesome, however, and our best efforts are sometimes frustrated by a partial sloughing of the bridge of skin, which, though it cures the patient, does not improve his appearance.

A simpler operation (Fig. 14) is to carry an incision from one end of the lid to the other, through its entire

thickness, at one-eighth of an inch above the margin, and to unite the ends of this by a second and curved incision, one-eighth to a quarter of an inch higher up, and through the skin only. The piece of integument included between these two lines is then dissected off. Another curved incision must now be made from one angle of the wound to the other, and a little below the last, through the muscular fibres and cellular tissue, down to the cartilage. The muscular and other tissue between this and the first incision is also to be removed, and the subjacent cartilage exposed. With the knife held obliquely, a narrow strip is now to be cut from the cartilage, the whole length of the wound, one-sixteenth of an inch wide on the outer, but beveled to a line on the inner surface. If the wound be now closed by deep sutures, which include everything but the cartilage, the lashes will be found to be well turned out. In the figure, one suture is shown in position. This operation requires care, but gives excellent results.

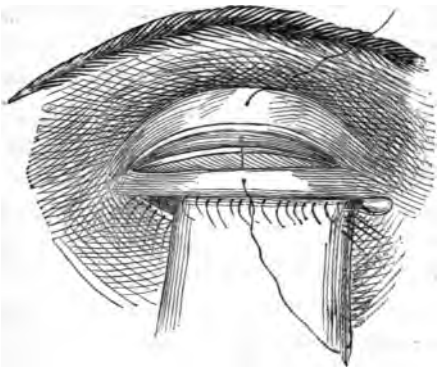

FIG. 14.

If the personal appearance of the patient is of little or no consequence, the operation known as *scalping* is simple, effectual, and easily performed. It consists merely in the entire removal of the slip of skin containing the roots of

the cilia, by means of an incision along the edge of the lid, just behind the lashes, and another along the front, one-eighth of an inch from the margin. The wound may be left to heal by granulation.

The entire inversion of the lower lid, before mentioned, may be readily controlled, if seen in the beginning, by turning the lid out and retaining it in its position by means of adhesive plaster, until the irritation which causes the entropium has subsided. If the affection is chronic, an elliptical slip may be cut from the skin with the scissors, the parts having been first pinched up, to find out how much it is necessary to take away. The edges of the wound should be united by sutures.

Ectropium or eversion of the lid, may exist in varying degrees. The lightest form is that pushing of the punctum away from the ball which occurs in old blepharitis with hypertrophied margins. The treatment is such as is applicable to that disease, combined with slitting of the canaliculus. Ectropium of the lower lid is often an accompaniment of paralysis of the facial nerve. The lid drops by its own weight, in consequence of the loss of support from the orbicularis, sags away from the ball, tears accumulate in the hollow, and irritation and swelling of the conjunctiva follow, pushing the cartilage over in its axis. Galvanization of the orbicularis suffices for the cure, although it is sometimes necessary also to slit the canaliculus.

Severe catarrhal or purulent inflammation of the conjunctiva, especially if prolonged, often produces ectropium. The conjunctiva becomes very much swollen and presses the lids apart, and spasmodic contraction of the orbicularis, or sometimes accident, everts the lids. Once everted the whole

lid is strangulated by the orbicularis and the conjunctiva becomes hypertrophied. The obvious treatment for this condition is to press the lid back into its place and keep it there by a compress and bandage, at the same time applying remedies to the inflamed conjunctiva. Perseverance in this course, often for weeks, is necessary for success. If the inflammation has subsided, and only hypertrophy and eversion remain, a narrow slip of the exposed and thickened conjunctiva may be excised from one end of the lid to the other. A strong silk thread with a needle at each end having been provided, one needle should be passed through the conjunctiva at a point between the wound and the edge of the lid, carried down behind the lowest part of the conjunctival sac and pushed through on to the cheek or brow, as the case may be, emerging one or two inches from the eye. The other needle is passed in the same way at from an eighth to a quarter of an inch distance from the first. Traction made on the ends of the thread will now pull the lid back into its place, and it may be secured in position by tying the threads over a small roll of plaster. Two or three such threads should be put in along the lid, so as avoid too much tension on one point. This is known as Snellen's stitch. If there is not much hypertrophy, the excision of conjunctiva may be omitted. If the lid has been lengthened by long continued existence of ectropium of this kind, a V-shaped piece may be cut from the middle of its border and the wound united by a hare-lip suture. Or, if the stretching is mostly at the outer end of the lid, a similar piece may be taken away close to the outer canthus.

The worst form of ectropium results from the contraction of cicatrices following burns, wounds and sloughing of

the skin and cellular tissues from inflammation. If seen sufficiently early the deformity may be prevented by paring the edges of the lids and uniting them by suture until the stage of contraction is passed. Even after ectropium has become confirmed, this method may be used, if the loss of tissue is not too great. The cicatrix must, of course, be divided and the skin loosened sufficiently to allow the lid to be easily

Fig. 15.

brought into apposition with its fellow. Large ulcers, from the loss of tissue, may be hastened in healing by grafts of skin taken elsewhere. Care must be used to protect them from pressure and to keep them warm.

Eversion of the lower lid in case the cicatrix is small, may sometimes be remedied by making a V-shaped incision of the skin of the cheek (Fig. 15), the two arms of the

V embracing the ends of the lid, dissecting up the included flap, which is to be left attached at the tarsal margin, freeing all adhesions, turning in the lid, if necessary, with a Snellen's stitch and bringing the two sides of the wound together, leaving a small V at the top.

The eversion, with lengthening, of the lower lid, which occasionally follows old blepharitis, may be remedied by Graefe's operation (Fig. 16), which consists in freeing the lid from its attachments by an incision behind the free edge, from the punctum to the outer canthus, and two vertical incisions, each three-quarters of an inch in length, from the two ends of the first. The included flap is to be dissected free, pulled upward and held in that position while it is fixed by sutures along the vertical incisions. A small V-shaped piece snipped from the corners remedies the excessive length of the lid. Conjunctiva and skin are to be again united by sutures, the free ends of which should be attached to the forehead to aid in retaining the parts in position.

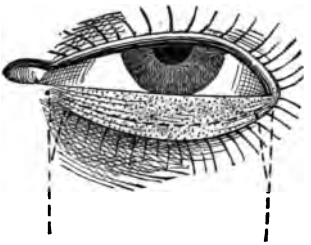

FIG. 16.

BLEPHAROPLASTY, or the operation of forming a new eyelid, must be had recourse to in cases where the cicatrices are extensive, binding the lid in its everted position, or when there is necessary loss of tissue from excision of tumors or otherwise. The operation consists in shifting a flap of sound skin from some adjacent portion of the face,

or even from another part of the body, to fill the gap left by freeing the lid from an abnormal position, or by the removal of a tumor. The flap should be taken from sound skin, if possible. It should be somewhat larger than the gap it is intended to fill, to allow for inevitable contraction, and to avoid stretching. It must be secured in position by numerous fine sutures. The base of the flap should be broad enough to maintain its vitality, and should be twisted as little as possible. The surrounding tissues should be stretched very gently, and if there is excess of tension in any direction, it should be relieved by appropriate incisions. The flap is very liable to slough, and must be nursed accordingly. There should be no bleeding from the surface to which it is adapted. Enough pressure must be used for twenty-four hours to insure coaptation of surfaces, but not enough to interfere with the feeble circulation. Afterward all pressure must be removed, and any indication of depressed vitality, or the appearance of a faintly purple patch near the end of the flap, must be met by the frequent

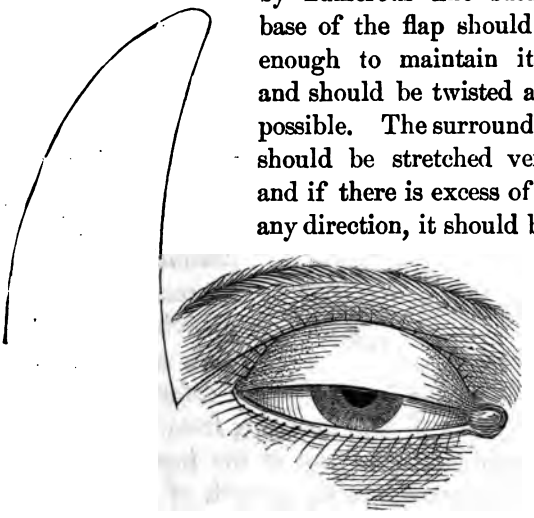

FIG. 17.

application of hot water, and the protection of warm cotton, without pressure, during the intervals. With regard to the direction of the incisions, much must be left to the ingenuity and good judgment of the surgeon, but the accompanying figures (Nos. 17 and 18) give the lines which are generally used.

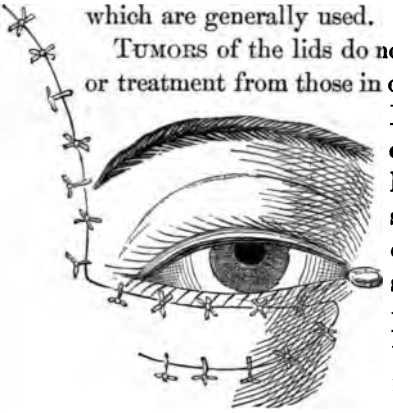

Fig. 18.

Tumors of the lids do not differ in constitution or treatment from those in other parts of the body. In excising them, it is especially necessary, however, to preserve sufficient skin for covering the parts without stretching. Wherever possible, particularly in the removal of *nævi*, it is advisable to use Snellen's clamp, to avoid bleeding. *Epicanthus* is a congenital deformity, consisting of a crescentic fold of skin, springing from the side of the nose and covering more or less of the inner canthus. It frequently disappears with the growth of the individual, but if persistent after the nose is fully developed, may be removed by the knife. *Coloboma* of the lid is a congenital fissure of the same character as hare-lip. It may be treated in the same way, by paring the edges and uniting them by deep suture.

CHAPTER III.

DISORDERS OF THE LACHRYMAL APPARATUS.

It is very uncommon to find the lachrymal gland the seat of disease. *Dacryo-adenitis*, or inflammation of the gland, is a very rare affection, comes on slowly, with hypersecretion of tears, and develops itself as an enlargement of the organ, due to cell proliferation. It pushes the eye out of place, and may endanger its integrity by stretching the optic nerve. If not amenable to the ordinary treatment of inflammation, the gland should be extirpated with the knife. *Dacryops* is a rare tumor, caused by obstruction of a duct of the gland and, if the upper lid be everted, appears just under the conjunctiva, as a bluish, translucent cyst, which may be emptied by pressure. A seton of fine silk, passed through its conjunctival walls, will suffice for its cure. In *tumors* of the gland, whether cancroid, cystic, hypertrophy, adenoma, etc., it is well to have recourse to operative measures at an early stage, in order to protect the eye. The ball may project down and inward, and be partially uncovered so that the cornea is apt to suffer. The stretching of the nerve may produce neuritis and subsequent atrophy. An incision for the removal of the tumors should be made close to the margin of the orbit, at its upper and outer angle. The gland reaches somewhat deeply into the

orbit, and care should be used to dissect out every trace of its tissue.

EPIPHORA, or watery eye, is annoying, not only from the discharge of tears over the cheek, but because the accumulated fluid collects in a wedge-shaped layer in front of the cornea, supported by the edge of the lower lid, and interferes, more or less, with vision. When not due to obstruction of the lachrymal passages, it will usually be found to depend upon the irritation of an incurved eyelash, a foreign body in the cornea or conjunctival sac, or to granulations or hyperæmia of the tarsal or retro-tarsal conjunctiva. Removal of the cause will, of course, relieve the symptom. *Occlusion of one punctum* may cause little or no annoyance from epiphora, the tears being carried off by the other. If troublesome, however, the punctum may be made patulous by means of a needle and kept open by the use of an Anel's probe.

OBSTRUCTION OF THE LACHRYMAL PASSAGES may arise from various causes and in various parts of the canal, but much the same treatment is involved under all circumstances. The mucous membrane lining the canaliculi becomes inflamed from contact with foreign bodies, or through extension of disease from the surrounding parts or the conjunctiva. Ulceration and stricture, or even obliteration of the canaliculus with epiphora, may result. A wound of this region may produce the same effect. Chalky concretions called *Dacryoliths* sometimes, though rarely, occur in the canaliculi, and give rise to obstruction and inflammation. A mass of fungi sometimes blocks up the canal. The growth is similar to the *leptothrix buccalis*, and is sup-

posed to be derived from the application of saliva to the lids. The fungus evinces its presence by causing epiphora and irritation at the inner canthus, and the canaliculus may be felt to be distended by a cylindrical mass. This, when removed by slitting up the canal, is found to be a yellowish or dark concretion, sometimes containing particles of chalk, and it is possible that it may occasionally degenerate into a dacryolith.

Acute Inflammation of the lachrymal duct may occur by extension of disease from the canaliculi, or the nose, as an incident in the course of chronic catarrh of the duct, as an accompaniment of erysipelas, either as cause or effect, or it may arise without obvious cause. The condition is known by the occurrence of an inflammatory swelling to the nasal side of the inner canthus. The lids and conjunctiva often participate in the swelling; there is much local pain and even febrile reaction of the system. The skin becomes involved, and is red and immovable. Soon fluctuation can be detected by the fingers, and the abscess will generally break on the surface below the *tendo oculi*, a ligament which connects the inner ends of the tarsal cartilages with the nasal process of the superior maxillary bone, and passes in front of the lachrymal sac. After a short time the swelling of the mucous membrane subsides, the canaliculi become patulous, and tears which enter the sac trickle out of the opening of the abscess, mixed with pus and mucus. Thus, a *Lachrymal Fistula* is formed, which, unless treated, is generally permanent. In some cases the lachrymal bone becomes carious as a result of the inflammation.

Acute inflammation frequently degenerates into a *chronic catarrh* of the duct. This affection, however, just as often originates by extension of inflammation from mucous surfaces with which the lining of the duct is continuous. It may be caused, also, by anything which creates a constriction of the nasal duct. Tears accumulate in the sac, distend it, and irritation or inflammation, with epiphora, follow. A small swelling may generally be perceived just to the nasal side of and somewhat below the inner canthus. Sometimes the swelling is so slight as to pass unnoticed. Pressure on this spot, however, with the tip of the forefinger, will cause a few drops of muco-purulent matter, mixed with tears, to flow from the puncta. This affection is most often developed in relaxed, debilitated or aged persons, who make no complaint except that of tears running over the cheek. The malady, however, is liable at any time to take on the acute form and run the course described above.

In the treatment of all forms of lachrymal obstruction, the first thing to be done is to relieve the tension of the sac or canaliculi. This is best accomplished by slitting up either the upper or lower canaliculus with a Weber's knife (Fig. 19). If the latter duct should be selected, the

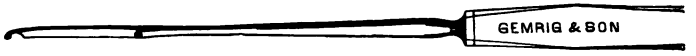

Fig. 19.—Weber's Knife, with long, malleable Shank.

lower lid must be made tense with the finger, while the probe-pointed beak of the knife is inserted into the punctum and introduced vertically for about the twelfth of an inch. The knife is then turned so as to be pushed horizon-

tally inward toward the nose, and slightly upward until the probe point touches the bone. The cutting edge, in the meantime, is held directed upward and backward toward the ball. Keeping the point gently in contact with the bone, and the lid tense, the handle is now raised to the perpendicular, and during this movement the canaliculus is laid open to the sac. The line of the incision should never be upon the free edge of the lid, but should be so managed as to coincide with the line of junction between the free edge and the conjunctival surface. The wound must be kept from uniting for three or four days, by the diurnal use of a probe. Afterward it remains open. If there is acute inflammation of the sac the contents will now be evacuated through the incision, aided, perhaps, by slight pressure, and a lead-water lotion may be applied over the swelling. If the tumefaction should be so great that it is impracticable to slit the canaliculus, the point of a bistoury may be thrust between the skin and the caruncle at the inner canthus, and an opening made directly into the sac, which is very superficial at this point.

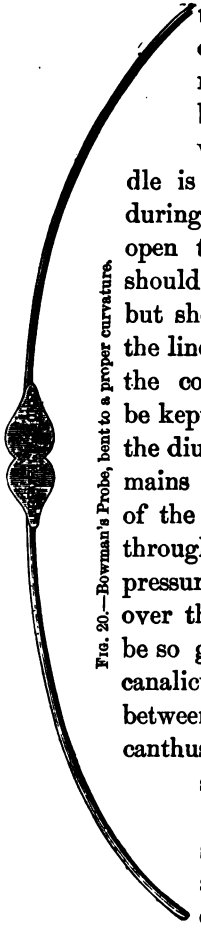

Fig. 20.—Bowman's Probe, bent to a proper curvature.

The sac must now be emptied by pressure several times a day, or as often as any accumulation takes place, and immediately afterward a small quantity of a solution of biborate of sodium, gr. iv–x ad f℥j, may be

placed in the depression at the inner canthus, and by movements of the lids made to enter the sac. After the inflammation has subsided, if the nasal duct has not become patulous, and at once in chronic cases, a No. 3 or 4 Bowman's probe (Fig. 20), should be passed through the duct down into the nose. The probe, which usually comes from the shop straight, should be bent to a curve, similar to that in the figure. It should then be passed horizontally through the slit canaliculus until it touches the bone, the lower lid, in the meantime, being held tense. When the point of the probe is felt against the bone, the lid may be released, the probe turned vertically, with the concavity of its curve presenting forward, and then passed gently down (Fig. 21) into the nose, where its presence may be recognized by touching its end, below the inferior turbinated bone, with another probe. The nasal duct does not pass directly down, but slightly backward and outward, so that when the probe is in position, its upper extremity rests near the supra-orbital notch. The curve of the duct varies somewhat in different individuals, and the probe must be bent accordingly. It must be left in position for a minute or two and then withdrawn. If there be no inflammatory reaction the probing may be repeated the next day. The time during which the probe is allowed to remain in

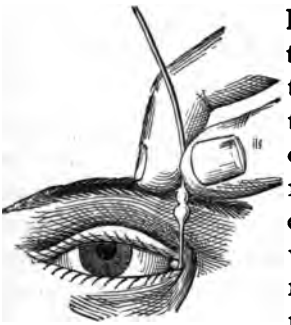

FIG. 21.—Introduction of Lachrymal Probe.

position should be increased daily, until it reaches fifteen or twenty minutes. All this time the treatment of the sac is to be kept up by means of astringent lotions, in the manner mentioned above. One of the best lotions for the purpose is boracic acid, gr. iv ad f℥j. Under the treatment the discharge soon diminishes, and in a short time the probing may take place at longer intervals; but even after apparent cure it should be performed once a fortnight, for some time.

If the patient should live at a distance, and the duct tolerates probing well, a lead wire may be introduced and allowed to remain for several months, if necessary. The upper end of the wire may be simply bent over on the cheek, and cut off, so that about a quarter of an inch of it is visible, or the short arm of it may be neatly shaped and proportioned with a knife, so as to lie snugly between the walls of the slit canaliculus, concealed from view. If, by examination with the probe, a stricture of the duct should be detected, it should be freely divided with the Weber's knife, which may be made with a long, malleable shank (Fig. 19), so that it can be bent for the purpose. Probing should then be carried on, as before mentioned. If there is a fistula, it will generally heal up under this treatment. In obstinate cases, with a tendency to recurrence, very large probes may be used, even to two or three millimetres in diameter, so that the duct may be stretched beyond the possibility of contraction. If all other treatment fails, or if the duct is absolutely impassable to the probe, the sac may be opened freely at the inner canthus, between the skin and the caruncle, and the interior cauterized with chloride of zinc, to destroy the walls and obliterate the cavity.

CHAPTER IV.

DISORDERS OF THE CONJUNCTIVA.

HYPERÆMIA of the Conjunctiva is characterized by more or less injection of the vessels, especially in that part of the membrane which lines the eyelids. If the lids be everted, there is found on their inner surface, in addition to the congestion, a swollen state of the papillæ, slight in degree, perhaps, but still noticeable, especially at the corners. The surface of the healthy conjunctiva, not only of the ball, but also of the lid, is provided with papillæ, similar to those of the skin. In addition to these, there are on the tarsal conjunctiva numerous papilliform elevations, which are very small at the edge of the lid, but increase in size as they approach the retrotarsal fold, where they become continuous with the numerous wrinkles of this portion of the membrane. In hyperæmia of the conjunctiva these papillæ and papilliform elevations, being somewhat swollen and congested, give to the inner surface of the lids a slightly velvety appearance. There may be also increased secretion of tears, accompanied by itching or pricking sensations, especially when the eyes are used for near work. Hyperæmia may arise from straining the eyes to see in a dull light. This is particularly apt to happen if the refraction is hypermetropic or astigmatic. It may also originate in exposure to irritating gases, smoke, high winds, or dust, or

from the entrance of foreign bodies into the conjunctival sac. By a continuance of any of these causes, not sufficient in degree or amount to produce inflammation, the disorder may become chronic. *Treatment* simply requires a removal of the causes which produce the affection, and the subsequent use of a weak astringent collyrium. It is well to bear in mind that, in every case of hyperæmia which continues without obvious irritating cause, the eye should be carefully examined for ametropia. Very often the adaptation of proper correcting glasses leads to a speedy cure. The collyria which will be found most useful, and which may be dropped into the eye three times a day, are biborate of sodium, gr.iv ad f℥j; sulphate of zinc, gr. ss–j ad f℥j; nitrate of silver, gr. ½ ad f℥j; plumbi acetas, gr.j ad f℥j; and vin. opii, gtt.vj ad f℥j.

Conjunctivitis, or inflammation of the conjunctiva, is of several varieties, dependent mostly upon the cause and on the grade of inflammatory action developed; but one form often passes into another, or two kinds may exist at the same time in the same eye.

Catarrhal Conjunctivitis is to some extent a type of all the others. The symptoms are those of hyperæmia, in an aggravated form. It begins usually with a feeling as of a foreign body in the eye, or with an itching of the caruncle or inner canthus, where a little mucous secretion is noticed. This soon increases in amount, and may become muco-purulent. The lids are found glued together in the mornings. The ball is covered by a network of vessels, and the tarsal conjunctiva is thick and velvety. There is intolerance of light, swelling of the lids, and the discharge

frequently runs over the cheek, producing excoriation. There is usually a sense of heat and discomfort about the eyes, and sometimes burning pain. As the case becomes worse, a rosy border of radiating vessels makes its appearance around the cornea, which rarely becomes involved, with superficial ulceration. Commonly the cornea remains bright and clear, and the iris active. Marginal blepharitis may be set up, and the lids feel so heavy that the patient can scarcely open the eyes. If the affection should become chronic, it may give rise to granular lids. The discharge is highly contagious, and many cases originate from the use of a towel by several persons in common, or by the accidental contact of individuals. If one person becomes affected in a family, or in an asylum, or school, the disease is very apt to spread, in one way or another. Overcrowding and lack of cleanliness accelerate its progress. It may originate also from cold, from the presence of a foreign body in the conjunctival sac, from diseases of the lids, from any obstruction to the removal of the tears, from the use of atropia, and also as a symptom of one of the exanthemata.

Treatment.—The first object is, as far as possible, to remove the cause of the disease. In view of the contagious character of the discharge, if the patient lives in a crowded community, he should be isolated; and, in the case of children, the best way to do this is to put them to bed. Slight cases tend to recover, without treatment, in a few days. An important point is the preservation of perfect cleanliness. The discharge should be thoroughly removed, as soon as it makes its appearance, with either warm or cold water, as is

more agreeable to the sensations of the patient. The eyes should be protected from the light, by means of a shade, by London-smoke glasses, or by confinement to a dark room, and the patient forbidden to attempt to read, or to do near work of any kind which requires the use of vision. If there is much burning pain and swelling of the lids, with great sensitiveness on the part of the patient, the use of a solution of biborate of sodium, gr. iv ad f.℥j, every hour, or oftener, with cold, wet cloths constantly applied during the intervals, gives great relief.

The manner of applying a collyrium is a matter of considerable importance, not only to the comfort of the patient, but also as regards the thoroughness of the application. If the eye is opened and a cold solution dropped on the ball, the shock is disagreeable, the lids close spasmodically, and the fluid is forced out before it has reached any parts except those nearest the edges of the lids. As the whole conjunctival sac is usually involved, however, it is desirable that the lotion should penetrate everywhere. This may be accomplished by placing the patient in any position, with the face horizontal and the eyelids closed, and by pouring a half teaspoonful of the fluid into the hollow at the inner canthus. The eye should then be gently but widely opened, by drawing on the skin of the lids, which should, at the same time, be pulled slightly away from the ball, and this action should be repeated several times in succession. If there is any sign of the cornea being involved, a solution of atropia sulphate, gr. j ad f℥ij, should be dropped in the eye, three times a day.

As the sensitiveness of the parts diminishes, the strength

of the solution of biborate of sodium may be increased, up to gr. x ad f℥j. Or it may be replaced by zinci sulphas, gr. ij ad f℥j, used three or four times a day, or zinci chloridi, gr. j ad f℥j. Of either of these, from five to twenty drops may be applied with a medicine dropper. If the discharge is very copious, and the eye not too irritable, a collyrium of argenti nitras, gr. j ad f.℥j, used three times a day, is very effectual. If this prove too exciting, a solution of tannic acid, gr. viij ad f℥j, will act admirably. Plumbi acetas, gr. j–ij ad aqua, f℥j, answers well, if the cornea is perfectly sound; otherwise, there is always a danger of a permanent white deposit of the carbonate in the tissue of the membrane. During the entire continuance of the treatment, the edges of the lids should be kept from adhering to one another, by the use of cosmoline, or other bland ointment. If the patient can be seen frequently, and the parts are not too sensitive, the duration of the treatment may be materially shortened, by everting the lids (page 26) daily, and painting their conjunctival surfaces with a four to ten grain solution of nitrate of silver, according to the violence of the inflammation and the copiousness of the discharge. The application may be made, by means of a stick or cotton holder, with a little mop of absorbent cotton twisted on the end. A similar mop, charged with warm water, should then be passed over the surface, to remove any excess of the caustic. A separate mop should be used for each eye, and the cotton should be renewed for every fresh application. If the affection shows a tendency to become chronic, no one solution should be used after its action ceases to be beneficial, and any of

those above mentioned may be employed, one after the other. But the daily application of nitrate of silver, in the manner before mentioned, to the tarsal conjunctiva, is especially effectual; care being used to diminish the strength of the solution as the condition improves.

AUTUMNAL CONJUNCTIVITIS.—About the middle or latter part of August, in every year, a number of cases of what at first sight appears to be a catarrhal conjunctivitis of a very aggravated type, begin to present themselves for treatment. The affection commences, as usual, with an itching or pricking sensation in the caruncle, or the conjunctiva in its vicinity. The two eyes are generally simultaneously affected, although one may be much worse than the other. The irritation soon spreads throughout the conjunctival sac, and while still moderate may be allayed by gentle pressure with the fingers. Redness and swelling of the conjunctiva of the lids, and suffusion of the ball, with lachrymation, follow the itching. The redness is especially noticeable at the inner canthus. Intolerance of light comes on as the vascular congestion spreads, and an attempt to open the eyes provokes a free discharge of tears and mucus, which ultimately excoriates the skin of the lower lid. The increase of the inflammation is accompanied by paroxysms of itching, which occur suddenly, at irregular intervals, and which excite an almost irresistible desire to rub the eyes. If this inclination is yielded to, there immediately follows an exacerbation of all the symptoms. The eyes burn, the papillary structure of the tarsal conjunctiva becomes hard and turgescent, and grates against the ball with its every movement. The tears and mucus are poured out in

abundance, and the lids become red, swollen and œdematous. Marginal blepharitis and styes occur, the lids are stuck together in the morning, and the disorder tends to chronicity, although it usually disappears with the occurrence of frost. As a general rule, there is more or less nasal catarrh, with sneezing, from the beginning of the disease; but often it is so slight that the patient does not notice it, unless his attention is specially called to it by inquiry. On the other hand, the ocular affection may be merely the initial symptom of an attack of hay fever.

Treatment.—So long as the acute symptoms persist, the disease appears to be aggravated by the local use of astringents, and, under the circumstances, the greatest relief will be obtained by the constant application of infusion of slippery elm bark, or sassafras pith, to the conjunctiva, with cosmoline to the lids at night. Oxide of zinc should be added to the cosmoline, in the proportion of three grains to the drachm, if the lids become excoriated. If the itching is intense camphor water may be added to the demulcent, in the ratio of one to four. As the tendency to the paroxysms of itching decreases, borax may be cautiously added to the slippery elm mixture. Finally, this may be abandoned in favor of a tannin collyrium, which will usually suffice for the cure. During the whole course of the affection quinine should be administered, in doses of one or two grains three times a day, and bromide of potassium given at night, in sufficient quantities (ten to sixty grains) to allay irritability. If the patient is troubled with chilliness, and is very sensitive to currents of air, ten drops of the tincture of belladonna may be added to each dose of quinine. The eyes

should, of course, be protected from the light and given as much rest as possible.

PURULENT CONJUNCTIVITIS is simply a more intense form of the same disease as that described as catarrhal. It begins with intense congestion, both of the ocular and tarsal conjunctiva. This hyperæmia is accompanied by numerous extravasations of blood in the tissue of the membrane. There is, at the same time, a rapid cell proliferation, which shows itself first as a thin, serous discharge; but in less than forty-eight hours there is a tendency to fatty degeneration, and the copious formation of creamy pus, which runs down over the cheek. At the retrotarsal folds, where the conjunctiva is most loose, there is the greatest amount of swelling. The lids are thrust away from the ball, with a tendency to eversion, and if the lid is turned accidentally, or by an attendant, and not at once replaced, the orbicularis contracts, the swelling increases, and this condition of *acute ectropium* is very likely to end in the destruction of the cornea, from want of protection. The tarsal conjunctiva is, at first, bright red and smooth; but in less than two days becomes velvety, from hypertrophy of the papillary structure. The conjunctiva of the ball is red, and at first infiltrated with a serous fluid; but as the inflammation becomes severe, the conjunctiva grows more dense and fleshy, standing up in a ring around the cornea, and overlapping its margin. This is the condition called *Chemosis*. The pain is often severe, and of a burning character. The tarsal integument is red, and the lids swollen, soft, œdematous, and increased in temperature. The upper lid, filled with morbid products, is too heavy for the

levator to raise. In some cases the pus is fibrinous in character, so that it may be peeled off in masses, often leaving an excoriated surface beneath, and such instances are sometimes described as a separate variety of disease, *Membranous Conjunctivitis*. The distinction, however, is of no especial value, and does not affect the treatment.

The complication which is really to be feared, however, is ulceration of the cornea, and this membrane is never safe until the symptoms commence to abate. It may be considered as an axiom, that the greater the chemosis the greater the danger, for the sources of nutrition of the cornea are more largely cut off. Frequently a narrow ulcer makes its appearance, running round the surface, parallel and near to the margin. This *Annular Ulcer* spreads in the direction of its length, often insidiously, partly concealed beneath the overhanging chemosis. The central portion of the cornea looks bright and clear, and the surgeon feels sanguine that valuable sight will be saved. In the meantime the ulcer has slipped round more than half the circumference, and the centre suddenly sloughs. At other times the morbid process commences as a spot of purulent infiltration near the margin, and rapidly extends, until the greater part of the cornea is involved; or several spots may simultaneously appear in different positions, perforation may take place, the iris presents itself in the gap, and iritis follows; or the whole interior of the eye may become involved. When the cornea bursts, the pain and tension are at once relieved, and the patient imagines that he is at last beginning to recover.

If the affection runs into a chronic stage, the papillary

structure of the tarsal conjunctiva becomes so much hypertrophied as to present a warty appearance, or finally, trachoma may be developed.

Purulent conjunctivitis arises, in rare instances, without assignable cause; oftener it comes on in the course of the catarrhal variety; but, most frequently, it is the result of contagion, either from the eyes of persons similarly affected, or from other sources. Newly-born children are sometimes infected by the secretions with which they come in contact in passing through the vaginal canal, or perhaps accidentally, a few days after birth. It is not safe to infer, in such a case, that the mother has gonorrhœa, for any muco-purulent secretion seems to be sufficient to give rise to the disease. Such an *ophthalmia neonatorum* frequently affects one eye only, but oftener both. The degree of the inflammation varies very much in different cases, probably owing to the nature of the infecting material; sometimes not advancing beyond the condition described as catarrhal, at others displaying the worst characteristics of the purulent form. *Gonorrhœal ophthalmia* is another variety, dependent upon contamination of the eye with the purulent urethral discharge, and is one of the worst forms of ocular disease to be met with in ophthalmic practice. Great care is requisite to save the sight of an individual suffering with this malady. The intensity of the symptoms, and the fact that the patient has a urethral discharge, are the only circumstances upon which a diagnosis can be based.

Mild cases of purulent conjunctivitis may be cured in a week or two, but severe ones last as many months. The later in the disease the corneal ulcer makes its appearance, the greater is the hope of saving the eye.

Treatment.—If one eye only is affected, the first thing to be accomplished is to make the other safe from contamination. This may be done in some cases by merely advising the patient of the magnitude of the risk he is running; but such a course should not be ventured upon unless the individual possesses considerable intelligence and self control. In any other case the sound eye should be covered in with a cotton compress and a bandage, or, perhaps, a watch crystal may be fixed over the eye by means of adhesive plaster, in such a manner as to allow of vision and yet to keep out all fluids. The patient should be isolated as much as possible, in order to avoid danger for others. In the commencement of the affection, if there is much swelling of the lids or conjunctiva, iced compresses must be applied continuously. On a block of ice, by the bedside, may be kept five or six pieces of folded, soft linen or muslin. Each of these must be large enough to cover both eyelids, and they must be used in rotation as fast as may be necessary to keep up the impression of cold. A large part of the time the patient may do this for himself, but a nurse must be at hand to relieve him when fatigued. If pain is severe, a few drops of a solution of atropia sulphate, gr. iv ad f℥j, should be placed in the eye every three hours until mydriasis is produced. If this does not afford relief, four or five Swedish or Spanish leeches should be applied to the temple, an inch behind the outer canthus. If the ocular conjunctiva is puffed up with serous exudation, four or five incisions may be made, radiating from the cornea; but these will probably be too late if deferred until a fleshy chemosis is established.

Great cleanliness should be observed with regard to the discharge, which, as fast as it appears, should be wiped away with scraps of rag or absorbent cotton. Astringents seem often to aggravate the affection so long as the discharge is thin and serous. The strength or frequency of use of astringent collyria must be in direct proportion to the amount of pus in the discharge, and on the nitrate of silver is our chief reliance. If the swelling is not too great to permit the access of an ordinary collyrium to all parts of the conjunctival sac, a solution of the salt, gr. ss–j ad f℥j, may be applied, as before directed, every half hour, hour or two hours. But, if we cannot be sure of the thoroughness of the application, it is better to evert the lids and to use a solution, gr. x ad f℥j, with the mop. The lids must be treated separately, the upper one while the patient rolls the eye as far down as possible, so as to expose the retrotarsal fold; the lower while the eye is rolled upward. If the cornea is ulcerated the excess of the caustic must be washed off before the lid is replaced. The frequency of this application must depend on the copiousness of the discharge, and so long as the white eschar which the caustic produces remains, it is worse than useless to repeat it. Generally, once a day is sufficient, or twice if the case is one of unusual severity. After each application the cold dressing must be renewed. Eversion of the lids under such circumstances always causes great pain, and should not be practiced any oftener than is necessary. A half-grain solution of nitrate of silver, a two to four-grain solution of alum, or ten-grain solution of borax, may be used every two hours or oftener in the intervals. The

strength of the caustic applications and the frequency of their use must diminish as the secretion and swelling become lessened.

Fig. 23.—Paracentesis Needle and Stilette.

It is of great importance in the treatment of these cases, especially in children, to get frequent and complete views of the cornea. But it is better to go without than to handle the eye roughly in the attempt, as the cornea may very possibly be burst in the process. In the case of a child, the upper lid should be gently raised with an elevator (Fig. 22). If there is ulceration a solution of atropia should be applied with sufficient frequency to obtain its full effect upon the pupil. If perforation has nearly taken place, the layer of corneal tissue constituting the floor of the ulcer being very thin and perhaps bulged outward by the pressure of the aqueous humor, paracentesis should be at once performed, with a needle (Fig. 23), in the corneal margin. The needle must be introduced through the corneo-scleral ring, if possible, and in such a manner that the blade may lie parallel to the plane of the iris, in order to avoid wounding the crystalline lens. When the puncture is completed and the instrument gently withdrawn from

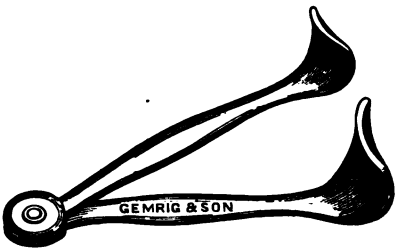

Fig. 22.—Lid Elevator, Double.

the wound, the evacuation of the aqueous humor soon gives a feeling of great relief. The wound should be reopened for several days in succession, with a stilette, or with the needle, if necessary, until the condition of the cornea shows that there is no longer any need for interference.

DIPHTHERITIC CONJUNCTIVITIS is a somewhat uncommon form of disease in this country. Every year, however, one or more cases present themselves at Wills Hospital. It is important, with regard to treatment, to be able to distinguish between this disease and purulent conjunctivitis. The essential feature of the affection is the exudation, within the tissue of the conjunctiva, of a pale, yellowish, firm effusion. This may occur in patches only, or it may invade the entire membrane. The severity of the disease depends upon the extent of tissue involved. The lids are hot, red, swollen and brawny, and the patient suffers considerable pain. It is often difficult to open the eyes, and eversion of the lids is accompanied by hemorrhage and severe suffering. The portions of the conjunctiva affected are yellowish in color, not red nor villous, and but little swollen. If the entire membrane is affected the eye is almost surely doomed to destruction. The stage of infiltration lasts from five to ten days, and is followed by suppuration, and finally by a shrinking of the parts involved, which, in the lids, gives rise to entropium.

Treatment.—The affection is contagious, and the same care must be taken to guard the sound eye, if one only is involved, as is to be exercised in the purulent form. Iced compresses should be applied to the lids with an industry proportioned to the amount of heat and swelling in the

parts. Caustics and astringents merely aggravate the disease during the first week, or as long as the process of infiltration is going on. When suppuration sets in the same local applications may be made as were recommended for purulent conjunctivitis. The general treatment for diphtheria, if any is necessary, must be dictated by the peculiar views of the practitioner.

TRACHOMA, *follicular conjunctivitis*, or *granular lids*, is a tenacious, insidious and destructive disease, which belongs mostly to the conjunctiva of the lids. It depends upon a deposit of lymph corpuscles, which may accumulate in little masses, like sap-sago grains, beneath the epithelium, or may be more or less infiltrated through the tissue of the conjunctiva. These grains may exist for a considerable time without causing irritation, or they may arise in the course of inflammatory conjunctival affections. If the lids be everted, their inner surfaces may be seen to be studded with round, yellowish, almost translucent granules, which are particularly abundant in the retrotarsal folds. If not the result of inflammatory disease, these granulations certainly predispose to it, and attacks come on sooner or later, attended with great irritability of the eye, profuse lachrymation, some mucous secretions, intolerance of light, and spasmodic resistance of the orbicularis to any attempt at examination. If the hot and swollen lids be everted, the distinctive granules are seen everywhere, projecting above the surface of the bright red and smooth tarsal conjunctiva. After the continuance for some time of severe inflammation, the normal papillary structure of the membrane becomes greatly hypertrophied, and this, interspersed with

the trachomatous granules, gives the everted lid the appearance of the granulating surface of a wound. As the inflammation subsides, the lymph corpuscles are replaced by cicatricial tissue, which seams the inner surface of the lids in all directions, and in contracting, like the tightened string of a bow, increases the concavity and apparently lessens the size of the tarsal cartilages, produces trichiasis and entropium, makes tense bridges across the conjunctival cul-de-sac and diminishes the extent of the membrane in every part. The worst form of this condition is known as *Xerosis*, and in addition to the almost total obliteration of the conjunctival sac, involves destruction of the glands which moisten the mucous membrane and consequent opacity of the cornea.

In the course of trachoma the cornea almost invariably suffers. Frequently vascular haziness commences at the upper edge and may spread thence over the entire membrane, covering it with an opaque, red coating, which is known as *Pannus*. Or phlyctenular ulcers may be developed, leading to perforation of the cornea and iritis.

Trachoma seems to depend often on unfavorable hygienic conditions, particularly on overcrowding. It affects especially the inhabitants of low, damp lands, is allied to lymphatic disease in other organs, and is at the same time contagious. If it effects an entrance into a school or asylum, it is difficult to dislodge, and every child attacked should, therefore, be separated from the others and be kept isolated until perfectly cured. Every individual should be provided with his own towel, which should be used by no one else, and all washing of faces and hands should be done

by means of water as it runs from a faucet. Basins should be discarded. From time to time all the eyelids in the house should be everted and examined, in order to detect the disease in its first stages. The hygienic conditions should, of course, be improved, if possible. Mild cases of the disease are amenable to treatment, and end in perfect recovery; but after severe forms of the affection the eyes always continue to be irritable, new attacks of inflammation supervene upon slight causes, and it is difficult to prevent some opacity of the cornea and impairment of vision.

Treatment.—This must be adapted to allay the inflammatory action in the conjunctiva, and at the same time produce absorption of the granulations. The lymph corpuscles of which the latter are composed penetrate too deeply into the tissue of the membrane to admit of their destruction by means of caustics, and the only way in which their removal can be attained is by stimulating the action of the absorbents. A variety of agents may be employed for this purpose, and the more irritable the eye the milder should be the application; the object being to avoid the production of inflammatory reaction. If there is but little redness or swelling about the lids, they may be everted and the granulations touched daily with sulphate of copper, the excess of which should be washed off with water, by means of a dossil of absorbent cotton, before the lids are returned to position. The copper for this purpose may be conveniently used in the form of a pencil, made by rubbing down a crystal of the salt to the proper shape. If the eye looks more irritable, a ten-grain solution of nitrate of silver may be applied with a mop, and the excess washed

off as before. A still milder application, and one from which the best results are often obtained, is a pencil of alum. To alternate with this, the Glyceritum Acidi Tannici of the U. S. Pharmacopœia may be used with a mop. These milder applications may often be used twice a day. If the irritation and swelling are great, the integument of the brow should be painted with tincture of iodine and the eye fomented, for ten minutes at a time, every two hours, with a hot infusion of extract of belladonna, ʒj ad Oj, or cold, wet compresses may be applied if more agreeable. If free secretion result recourse may again be had to the solution of silver. If no relief follows in two or three days, an eight-grain solution of tannin may be instilled three times a day. Pannus generally yields to the judicious treatment of the lids. If the tarsal conjunctiva become smooth and cicatricial, mild applications only should be made. If trichiasis or entropium result, a suitable operation should be performed for their relief. In inveterate cases of pannus which defy all the above-named remedies, it is allowable to inoculate the conjunctival sac with gonorrheal discharge, but the instances which require such heroic treatment are fortunately rare. The resultant inflammation in such a case is permitted simply to run its course, and the subsequent clearing of the cornea is a matter of time. It will not be safe to resort to this method if there is the smallest portion of clear cornea to be seen.

PHLYCTENULAR CONJUNCTIVITIS is an affection characterized by the appearance of one or more papules or vesicles upon the ocular conjunctiva, generally near the cornea. Each papule or *phlyctenula* is seated in a little

patch of congestion, toward which converge enlarged vessels from the equator of the eye. In a few days the summit of the phlyctenula generally becomes converted into a pellucid vesicle, which bursts, leaving a shallow ulcer with a yellowish floor, and healing soon takes place. The manifestations of the disease are somewhat variable. In some cases little patches of congestion only mark the tendency to the eruption, which never gets beyond this stage. In others one or more minute vesicles suddenly appear, without any hyperæmia, remain a day or two and disappear. Sometimes the affection assumes a chronic form, and a ring of thickened, moderately congested tissue surrounds the cornea and remains there for months. The patient experiences but little annoyance from phlyctenulæ seated upon the conjunctiva. There is but little, if any, pain or intolerance of light. When the disease attacks the cornea, however, it is very distressing; but this form will be considered in a future chapter.

Children are more liable than adults to an eruption of phlyctenulæ, and the appearance of the disease may be considered as indicative of derangement of the general health of the individual. When the attacks are recurrent, as is frequently the case, they may always be traced to some vice of the constitution, to improper food or other defect in hygienic conditions. The children of the poorer classes are especially liable to the disease, and it is not improbable that the use of nervous stimulants, such as tea and coffee, at a tender age, has often much to do in producing the result.

Treatment.—An ointment of the yellow oxide of mer-

cury, gr.j ad cosmoline ℥j, is the stereotyped remedy for this malady. A piece about the size of a small shot may be placed in the conjunctival sac, between the lower lid and the ball, twice a day. The salve quickly melts, and should be gently rubbed around by means of the closed lids. In some cases there is considerable conjunctival hyperæmia, and a collyrium of tannin, gr. viij ad f℥j, used three times a day, will be better tolerated than the salve. This solution is liable to undergo change, and should be made afresh if any precipitate appears in it. A favorite collyrium is composed of corrosive sublimate, gr.j, water f℥vj. It is somewhat more irritating than the tannin solution. The latter is an excellent remedy in cases which are disposed to become or are already chronic. Calomel, dusted in lightly with a camel's hair pencil once or twice a day, is a mild and generally efficacious remedy.

PTERYGIUM is a thickening of the conjunctiva, of a triangular shape, with the point resting on the cornea. The base is sometimes only a few lines from the cornea, but it usually extends to the inner canthus, and very few pterygia occupy any other than the nasal side of the eye. If conjunctivitis occurs, the growth causes annoyance by becoming swollen and irritable. Pterygium is mostly caused by long-continued irritation or inflammation of the conjunctiva, but may also arise from cicatrices. It is composed of a hypertrophy of the connective tissue elements of the conjunctiva. It very rarely grows sufficiently far across the cornea to cover the pupil, or becomes large enough to interfere with the movement of the eye.

Treatment.—If there is conjunctivitis, the appropriate col-

lyria, etc., should be employed, and with the subsidence of the inflammation the pterygium ceases to be troublesome. If the growth should be objectionable, on account of cosmetic considerations, it may be readily removed by an operation. Arlt's method is the one usually followed, and is most satisfactory in its results. The whole thickness of the pterygium should be grasped, at the corneo-scleral junction, with a pair of fixation forceps (Fig. 24), and the portion overlying the cornea should be cleanly dissected off with the point of a Beer's or other sharp knife. Then, with a pair of scissors which cut well at the point, the growth should be freed from the conjunctiva on each side, and neatly dissected up from the sclera, for a quarter of an inch or more from the border of the cornea. Lastly, the conjunctiva from each side, having been loosened from the sclera if necessary, may be brought together in the middle of the wound by a suture, and the pterygium left to atrophy.

Fig. 24.—Fixation Forceps.

If the mass is very large, this procedure may be varied by dissecting up the pterygium to the inner canthus, loosening the lower flap of the conjunctiva freely from the sclera, turning the pterygium down behind the lower lid into an incision made in the conjunctiva to receive it, stitching it there and bringing the conjunctiva together by sutures across the gap from which the growth has been dissected.

Pinguecula is a small collection of fat or yellowish connective tissue, under or in the conjunctiva, at the margin of the cornea, in the horizontal meridian of the eye. It is sometimes annoying, on account of its appearance, and may be readily dissected off.

FOREIGN BODIES in the conjunctival sac generally fix themselves under the upper lid, or in the retrotarsal folds. They are readily found by everting the lids (page 26) and if concealed in the retrotarsal folds, may be brought into view by causing the eye to be rolled strongly downward or upward, as the case may be. An easy method of everting the upper lid, if the eye is not deeply set, is as follows: the patient should be told to look down, the thumb of one hand should be pressed against the forehead just above the eyebrow, and at the same time the cilia should be taken between the finger and thumb of the other hand, and the lid gently pulled away from the ball. The eyebrow and other tissues are now slid down behind the lid, by the thumb on the forehead, and the palpebral conjunctiva at once presents itself externally. The lower lid may be everted on the same principle, the eye being turned up.

HEMORRHAGES under the conjunctiva occur from injuries and other causes, and are of no consequence. They are usually absorbed in a few days.

BURNS result mostly from the mineral acids, lime and molten metals being splashed into the eye. They cause conjunctivitis, which is to be treated by bland applications, but is often tedious. If the mucous membrane is destroyed, cicatricial adhesions are almost sure to take place between the lid and the ball, constituting *symblepharon*. All traces of the foreign body must be removed from the conjunctival sac, and if lime or acids have intruded, they must be got rid of as quickly as possible, by free syringing with lukewarm water; the lids, of course, being everted. Soothing fatty substances, especially vaseline, should be frequently

applied to the eschar. If the raw surface left by the burn is small, adhesions may be prevented by lifting the lid away from the globe every half-hour until cicatrization takes place. If the burn is small and at the palpebral fold only, the resulting adhesions will not be troublesome, and may be allowed to take place. But if the palpebral fold is involved, and the injured surface large, it is best to keep the lid everted until the ulcer is healed. No difficulty will be found in accomplishing this for the upper lid, but in order to keep the lower one turned it will usually be necessary to divide the outer canthus.

SYMBLEPHARON.—A definition of this condition and some account of its mode of origin, and of the methods to be pursued in order to prevent its occurrence, may be found in the preceding paragraph. The cornea is generally involved in the cicatrix (Fig. 25) which usually springs from the lower lid. Sometimes the adhesion consists merely of a narrow bridle, which cannot be seen except by pulling the lid away from the ball, and causes little or no inconvenience. If a large part of the lid is united to the globe, however, the consequent interference with the motions of the eye keeps up constant irritation, which may result in destruction of the sight of the organ, and even in sympathetic inflammation of the other eye. In any case where the mobility of the globe is limited by the symblepharon, and an operation for

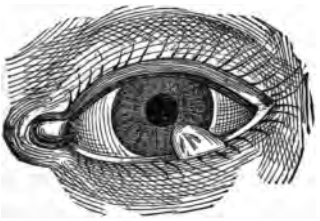

FIG. 25.

its removal is likely to succeed, it is advisable to operate as soon as possible. Success in such a procedure depends upon our ability to prevent a raw surface on the ball from coming in contact with one on the lid.

If examination, by means of a probe, shows that the cicatricial bridle does not extend to the palpebral fold, the opposing surfaces may be separated by the knife and prevented from adhering again by frequently drawing the lid away from the ball until the wound be healed. But if the adhesions involve the retrotarsal fold this method is not practicable. Cicatrization commences again at the bottom of the fold and goes on to the free edge of the lid. Lead plates, and other devices introduced to keep the healing surfaces apart, are pushed out of the commissure by the growing cicatrix. Success may often, however, be obtained by everting the lid and keeping it in that position until the wound is healed. A better method than these, if the bridle is small, is to separate the opposing surfaces and to bring the edges of the orbital conjunctiva together over the wound by sutures, having previously loosened the normal attachments of the membrane to the sclera. This brings sound conjunctiva in contact with the raw surface on the lid, and healing takes place without adhesion.

If a membranous process encroaches upon the cornea and the adherent surface between lid and globe is narrow, a fine thread may be passed through the apex of the growth, which should then be nicely dissected from the cornea and down to the edge of the lid. The latter is then to be freed from the ball as far as may be necessary. A curved needle should be put on each end of the thread and

both of them passed through the depths of the retrotarsal fold, close to the orbital margin and out on to the cheek. By drawing on the ends of the thread, the loose tongue-like process may now be brought down into the wound on the inner side of the lid and made to present its sound face to the globe. The threads may be secured over a roll of adhesive plaster on the cheek. This is substantially Arlt's operation. If the wound on the ball should prove to be wider than the flap from the cornea, the ocular conjunctiva must be loosened on each side and drawn together as well as possible, to fill the gap. If the tension is too great, it may be relieved by appropriate incisions, on the same principle as in plastic operations on the skin. Or flaps of conjunctiva may be taken from convenient positions on each side of the eye, slid into the edges of the wound and fastened by sutures. If more than half the lid is involved, an operation by this method is hopeless, as sufficient tissue cannot be obtained to fulfill the conditions of success.

ANCHYLOBLEPHARON is a condition where the lids are adherent to one another. The cornea and conjunctiva are frequently involved as well, so that, in these cases, it may be considered as an extensive symblepharon. It is sometimes caused by burns, but may result also from protracted blepharitis with ulceration. If the edges merely of the lids are adherent, they may be divided on a director and painted with collodion. But if the cornea is much involved, no operation is likely to meet with success.

LUPUS, beginning in the lids or face, sometimes invades the conjunctiva. Destruction of the sight is the final result.

POLYPUS generally arises near the inner canthus. It is usually of small size, globular, and attached to the conjunctiva by a narrow pedicle. It is composed of connective tissue cells, and grows from an injury or abrasion of the conjunctiva. It often occurs after the operation for strabismus. It is sufficient to snip off the growth, close to the base, with a pair of scissors, and cauterize the points of attachment. If the patient is nervous about the use of the scissors, the polypus may be removed by touching it every day, for a week or two, with a pencil of sulphate of copper.

TUMORS rarely occur upon the conjunctiva, except by extension from adjacent surfaces.

CHAPTER V.

THE OPHTHALMOSCOPE.

Before proceeding further with the consideration of the diseases of the eye, it will be best to learn something of the instrument which is our principal reliance in matters of diagnosis. The eye may be considered practically as a closed chamber which is lighted by a single, small window, composed of a double convex lens. The reason we cannot see into this chamber is because that part of its

FIG. 26.

wall which is in our line of vision is always dark, being occupied by the image of our own eye. In the pupils of albinos, on the contrary, we see a red light, because the iris and sclerotic are so much less opaque than in other eyes, that the interior is generally illuminated. Donders proved this by placing a screen over all parts of such an eye, except the pupil. The latter at once became black.

To see into an ordinary eye we need the assistance of

rays coming from some luminous point. But when the organ is lighted by a candle, the rays, proceeding outward again from the brilliant image on the retina, go back to the candle. This is in accordance with the *law of conjugate foci*, upon which is based the theory of the construction of the ophthalmoscope. To illustrate the action of this law, we will suppose the rays from the lamp L (Fig. 26), after passing through the double convex lens, to be focused upon the screen at *l*. Now, if the lamp and screen should change places, it is evident that the rays from *l* would go to L. The two points, L and *l*, are called the conjugate foci.

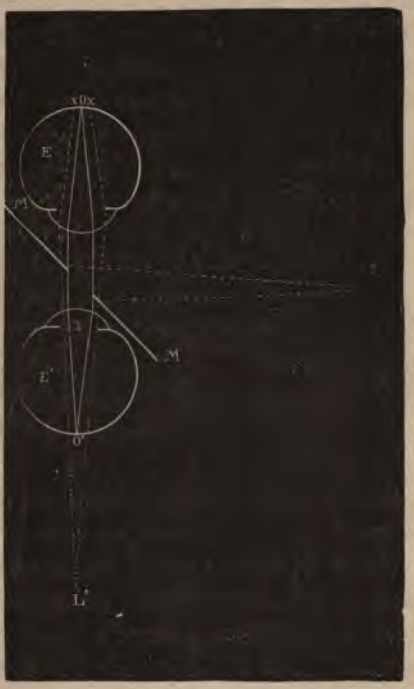

Fig. 27.—Principle of the Ophthalmoscope.

It appears, at first sight, to be impossible for the observer to get into the path of the rays which are returning from the luminous image to the candle; but this feat Helmholtz accomplished very simply, by reflecting the candle light into the eye by means

of a mirror and catching the rays on their return, by looking through a hole in the centre of the glass.

Let M M (Fig. 27) be the ophthalmoscopic mirror, placed obliquely, so as to reflect the rays from the light L, into the eye E, which is under examination. To this eye the rays appear to and practically do come from the projected image of the light at L′. If the eye of the observer E′ is now placed behind the hole in the mirror, it receives a large portion of the rays which are returning from the illuminated surface x x, to the source of the light. Such rays, arising at *o*, are focused upon the retina of the ob-

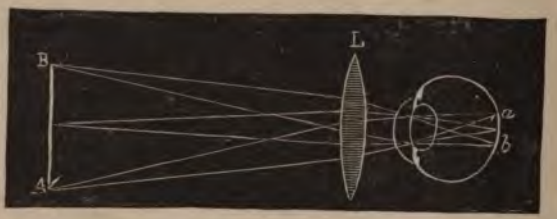

Fig. 28.

server at *o′*, and enable him to see the details of the illuminated portion of the organ from which they came.

As everything appears in its actual position by this method, it is known as the *examination of the erect image.* And, as nothing intervenes between the mirror and the eye examined, it is also known as the *direct method of examination.* It is substantially the one in most frequent use today, and all working ophthalmoscopes are constructed upon the above described principle.

It is frequently convenient, however, to examine *the inverted image.* This is obtained by placing a double con-

vex lens, L (Fig. 28), before the eye which is under examination. Then, if we suppose *a b* to be the illuminated details of the retina, an inverted image thereof, B A, will be formed at the focus of the lens; precisely as an image of an object B A placed at the focus would be inverted on the retina at *a b*. The inverted image B A is formed in the air, and is conveniently examined by means of a double convex lens of ten inches focus, placed behind the hole in the ophthalmoscopic mirror. This is known also as the *indirect method of examination.* The lens behind the mirror enables the observer to get close to the inverted image without straining his accommodation. It also enlarges the apparent size of the image.

Many ophthalmoscopes are in use at the present time, under the names of different inventors. These names refer to some slight variation in the mechanical construction of the instrument. The essential features of the ophthalmoscope are, however, always the same, and although anybody may add a lens, or a screw, and call the result his invention, most of such complications will eventually be relegated to the museum of ophthalmological curiosities.

It has been found convenient, in practice, to use a concave glass mirror of from twenty-five to thirty-five millimeters (one to one and three-eighths inches) in diameter, and of eighteen to twenty centimeters (seven to eight inches) focus. A medium size is preferable, in order that it may be placed close to the eye of the observer, the upper edge fitting under the brow. It is thus more readily steadied in position. The concave form of the mirror is advantageous, because of the greater concentration of light it

affords. The central perforation should be about three millimeters (one-eighth of an inch) in diameter, in order to allow as many rays to pass to the observer as may be possible without impairing the supply of light to the eye under examination.

The edge and back of the mirror should be cased in metal, so as to prevent it from being easily broken and to afford a firm point of insertion for a convenient handle or other appliances. As all eyes are not emmetropic, we need also to use a number of lenses, behind the central perforation of the mirror, in order to see clearly the details of the retina. This application of the lenses will be explained in a future chapter, in connection with the subjects of myopia and hypermetropia. Even in emmetropia, however, we frequently wish to examine objects in different portions of the eye, anywhere between the retina and the anterior surface of the cornea; and as rays from such intermediate positions would necessarily leave the eye in very divergent directions, we need double convex lenses of various focal distances, to collect such rays and, by making them parallel, to enlarge the apparent image of the object. Helmholtz employed the disk of Rekoss as the most convenient mode of using lenses for his ophthalmoscope, and the same form is employed to-day. This disk contains a number of small lenses near its margin, and by rotating it behind the perforation in the mirror, a considerable variety of powers may be used in a short space of time.

The patterns of ophthalmoscopes in most frequent use in this country are those devised by Doctors Knapp and Loring (Figs. 29 and 30). It will be seen that they differ

in unimportant details of mechanical construction only. These instruments contain each a single disk, with a suc

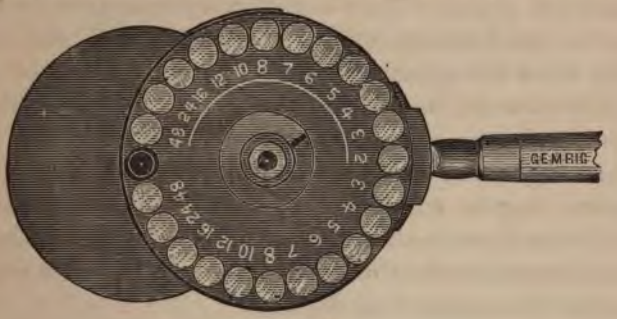

FIG. 29.

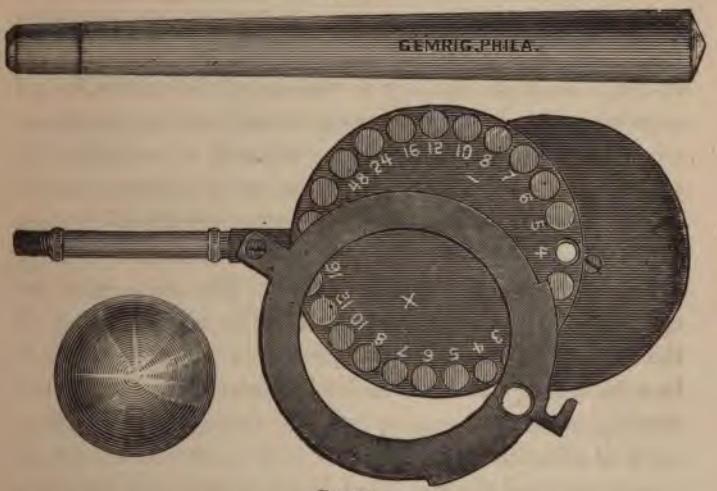

FIG. 30.

cession of convex and concave lenses and one empty space. Other instruments are made to contain two disks or parts

of disks, so arranged that two lenses may be superposed behind the central perforation, in order to obtain a greater variety of powers. The forms of instrument given in the figures are, however, sufficient for all practical purposes. The fewer the number of lenses the less the cost of the ophthalmoscope, and some forms are constructed with a special view to cheapness. They answer very well for general purposes of diagnosis, but are of small value in determining the refraction of an eye. In the ophthalmoscope case there should always be two double convex lenses, each one and one-half inches in diameter and of two and a half or three inches focal distance.

THE MANNER OF USING THE OPHTHALMOSCOPE is very simple, but it nevertheless requires practice to obtain the dexterity which gives the observer confidence in his results. As a preliminary to the use of the mirror, in all cases where we have any reason to suspect that the structures of the front of the eye are affected, we examine the organ by means of FOCAL or OBLIQUE ILLUMINATION. This consists in lighting up the anterior parts of the eye by means of the point of a cone of light thrown by a large lens of two or three inches focus. The room used for ophthalmoscopic purposes ought to be so arranged that all the light in it proceeds from one source. This source may be a hole, of two or more inches in diameter, in the window shutter, or in an opaque screen, through which daylight is admitted, or it may be any convenient form of steady, artificial flame. That of an Argand gas burner is very efficient and easily managed. The patient should be so placed that the light falls on his face, but more or less

from the side, according to circumstances. The hand holding the lens should be steadied on his temple or brow, while the other hand is occupied in controlling the eyelids. The focus of the rays passing through the lens may now be applied to all parts of the cornea, the anterior chamber, the iris, the lens, and of the superficial portions of the vitreous which are within our range of vision. Any point which we may wish to particularly observe may be magnified by means of a second lens held by the hand which controls the eyelids. It is often necessary, in order to make a thorough examination, to shift the position of the patient so that the light may come first from his temporal, then from his nasal side.

THE ERECT IMAGE may next be examined. It is best for the beginner to dilate the patient's pupil before using the mirror. A drop of a solution of atropia sulphate, gr. ¼ ad f℥j, placed between the lower lid and the ball, will accomplish this result in an hour. Or a drop of a solution of homatropin hydrobromate, gr. j ad f℥j, will produce the same result in half the time. In either case the pupil will have returned to its natural condition the next day.

The patient and physician may most conveniently be seated, although it often saves time to make examinations in the erect position, especially in hospital and dispensary practice. Whatever the position selected, however, the eye of the observer, the eye examined and the light should be, as nearly as possible, in the same horizontal plane. This is merely for the convenience of the student, for, as he becomes expert with the instrument, the light may be shifted in various positions with advantage. To examine

the right eye the physician may be seated by the right side of the patient and facing him. The light must be at a convenient distance behind the head of the person under examination and just far enough to his right to shine on his temple. The surgeon must take the mirror in his right hand, and with his own right eye applied to the central perforation, attempt to illuminate the pupil.

To keep the centre of the cone of rays reflected from the mirror directed steadily into the pupil, is often a difficult task for the beginner, but will be acquired by practice. He may learn to control the instrument for this purpose, by using a spot on any sort of a temporary screen placed in front and to one side of the light. The image of the flame may be cast on the spot and the effort made to keep it there while the head is moved in different directions, back and forth and from side to side.

It is generally best to begin the examination by using a convex lens of ten inches focus, behind the central aperture of the mirror. The physician must bring his eye within about ten inches of that of the patient, so as to focus any opacities in the cornea, lens, or vitreous. If the patient now rolls his eye about, any floating shreds which the vitreous may contain are stirred up and pass through the line of vision. At this distance also we detect adhesions of the iris, commencing cataract, intraocular tumors, separated retina and foreign bodies in the anterior portions of the eye.

Then, turning the disk so that the empty space coincides with the aperture of the mirror, the head must be advanced to the distance of an inch from the eye under examination.

If the patient now directs his eyes a little to his left and fixes them on a spot on the opposite wall, a little above the level of his head, the point of entrance of the optic nerve, or the *optic disk*, as it is called, is brought into view. This is supposing both the observer and the person examined to be emmetropic or moderately hypermetropic. If the observer is ametropic, his ametropia must be corrected by an appropriate lens. If he is using his accommodation he will require a concave lens. If the patient is myopic a concave lens must be turned into position. If highly hypermetropic, a convex lens must be used. The method of measuring the refraction by means of the ophthalmoscope will be explained in a future chapter, while considering the subject of ametropia. All that has been said about the examination of the erect image in the right eye may be applied with equal force to the examination of the left, by simply dropping the word "right" and using the word "left" in its place, and vice versa, in the foregoing paragraphs.

In making this examination the surgeon should rid himself of the idea that he is looking at a near object, but imagine himself gazing at the moon on the distant horizon. In this manner all strain on the accommodation is relieved. If the disk is not seen at first, but a vessel only caught sight of, this may be followed up until the disk is found. Other parts of the retina should then be examined in succession, the patient being told to look up or down, or to either side, or directly at the reflection of the light in the mirror, until the entire field is gone over.

Daylight is preferable to artificial light, if we wish to judge of the true color of the optic disk or other parts of the fundus.

It often happens, for a variety of reasons, for instance, from haziness of the vitreous, or from a high degree of ametropia, that we cannot obtain a clear picture of the fundus oculi. We must then have recourse to the indirect method of examination. THE INVERTED IMAGE may be conveniently observed while the physician and patient occupy the same positions as before, and both eyes of the patient may be readily examined from either side. If we suppose the right eye again to be the subject of investigation, the surgeon should use the mirror with his left eye. The double convex lens should be held at about its own focal distance from the illuminated pupil, and steadied in position by a finger resting on the temple or the malar bone. The surgeon's head should be about fifteen inches distant from that of the patient, who should look at the right ear of the former. This movement brings the optic disk into the line of vision. If the surgeon is prevented from seeing the disk by annoying reflections from the surface of the lens, it is only necessary to turn the latter a little obliquely on its vertical axis, in order to get rid of them. The disk may then be accurately focused by moving the head a little backward or forward, as the case may be.

After some practice in examining the disk in this way, it will be well for the surgeon to shift the mirror to his right eye and to direct the patient to look straight before him, at a point on the opposite wall a little above the level of his eyes, and then to seek for the disk in its proper position to the nasal side of the optic axis. The rest of the fundus should afterwards be brought into view, by telling the patient to turn his eyes in the various directions

required. Considerable latitude of field may also be obtained by merely moving the convex lens about a little, but keeping it at the same distance from the eye. The lens must, of course, always be in the line between the aperture of the mirror and the pupil, and the latter must be kept steadily illuminated.

To see the optic disk in the left eye, the mirror should be used before the right eye of the surgeon while the patient looks at the left ear of the former; or the patient may look at a spot on the wall and the surgeon may then search for the disk in its known place, using either eye.

As the position of everything is reversed in the inverted image, it will always be necessary, if we wish to catch sight of an object again, to move the head toward that side of the pupil under which the object seems to recede. Every part of the fundus oculi should be examined, and if any portion presents pathological appearances, these should be carefully studied in the enlarged image which the direct method affords.

THE OPHTHALMOSCOPIC PICTURE of the fundus oculi is not always seen at once by the beginner. Generally his first impression is of a diffused redness, from which appearance he has even been known to diagnose general retinitis, but which in reality is owing to the normal circulation in the choroid. In an examination of the eye-ground the first object sought must be the optic disk. This is not only a landmark which serves to indicate the direction and position of any other point, but it is also a measure of sizes and distances. A hemorrhagic effusion, for instance, may be noted as so many disk diameters from the disk, and the

size may be measured by comparison with the disk's area. The average actual diameter of the disk is 1.5 millimeters. The optic nerve entrance is found by causing the patient to look at the opposite wall and to fix a point to the nasal side of the eye examined and slightly above it. The nerve joins the eye at right angles to the sclerotic (Fig. 31), but the white, opaque sheath of myeline which envelopes each nerve fibre ceases at the lamina cribrosa (*l*), and only the naked, transparent axis cylinders enter the interior of the organ and spread out in all directions over the retina (R), forming its inner nerve-fibre layer. Thus, in looking at the end of the nerve, it appears to us as a round, oval, or sometimes irregularly-shaped disk, which is bordered by a black line, the *choroidal ring*, showing where the choroid (*Ch*) is perforated. This ring may be visible as a crescent only, or in the eyes of blondes

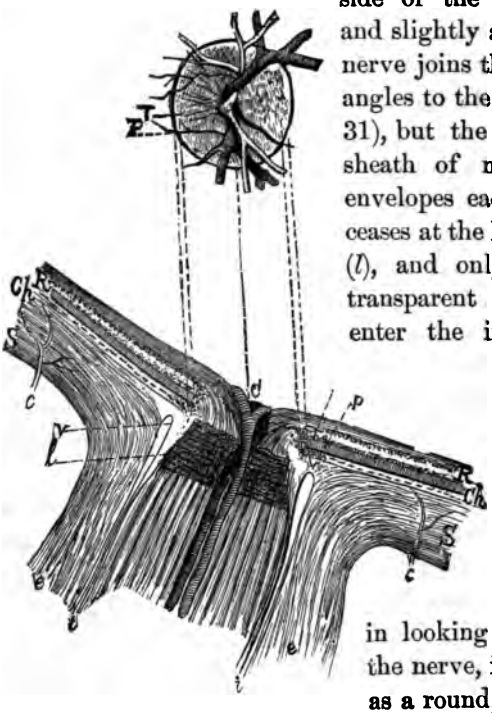

FIG. 31.—The Optic Disk and the Mode of Entrance of the Optic Nerve into the Eye.

not at all. Just within the choroidal is the white, scleral ring (T) which shows where the internal sheath of the optic nerve terminates. As the nerve fibres pass forward from the lamina cribrosa, they spread out in a convolvulus or trumpet-shaped manner, leaving a small, central funnel, the *porus opticus* (*c*), through which enter the retinal vessels.

Sometimes however, the fibres commence to spread before reaching the lamina cribrosa, and thus enter the eye, leaving a large, central, axial hollow in the disk, forming the so-called *physiological cup*. This is occasionally exaggerated to such an extent as to closely resemble the pathological excavation which the nerve presents in glaucoma, but may always be distinguished therefrom by the fact that the cup never extends quite to the scleral margin. The nerve fibres, in such a case, may be seen most readily on the nasal side and they are often difficult to discover on the other. In exceptional instances the mass of axis cylinders may pass entirely to one side of the centre, giving the disk an oblique and unusual appearance. At the bottom of the cup is always visible the white lamina cribrosa, mottled with dark perforations.

The color of the optic disk is a rosy pink, which is deeper on the nasal side, from the fact of the somewhat greater mass of tissue in that half of the circle. The rosy color is, of course, due to the blood in the capillaries, and the disk becomes white when it has undergone atrophy. It looks much paler in a brunette than in a blonde, on account of the contrast which the deeply-pigmented eye ground of the former presents. To appreciate fully the actual color of

the disk the eye must be examined by means of daylight. The yellow element of the artificial light always disguises to some extent the real colors of the fundus oculi.

The Retina is not absolutely transparent, and in a dark eye, especially by daylight, it may be seen as an opalescent film covering the fundus oculi. In some cases opaque, white striæ radiate from the disk, mostly on the nasal side, but often above or below, owing to the retention by some fibres of their nerve sheaths after passing the lamina cribrosa. The appearance has no pathological significance. The retina becomes opaque and visible when detached from the choroid.

The macula lutea is an important subject for examination and should never be neglected. In the erect image it may be brought into the line of vision by causing the patient to look at the light in the mirror. The pupil must be dilated for a satisfactory observation in detail. In the inverted image the macula may be found by directing the patient to fix his eyes on the forehead just above the mirror. By using daylight it will be seen that the yellow color is a purely post-mortem phenomenon. On account of the thinness and transparency of the retina at this point the vascular and pigmented tissues of the choroid beneath show through more plainly than elsewhere, and the macula is consequently distinguished by a deeper red or somewhat browner hue than the surrounding parts. Sometimes its position can be known by the absence of vessels only.

The retinal artery and vein both bifurcate at the level of the retina, usually one branch going up and the other down before they curve round toward the macula. Sometimes

however, the bifurcation takes place deeper in the nerve and the branches appear on the disk, or even at its margin, as separate vessels. The veins are of a deeper tint than the arteries, and both have a central line of lighter color, which is more marked in the latter. This line probably depends upon the reflection of light from the posterior inner surface of the vessels. A common object of remark is the pulsation of the retinal veins, which, if not present, may be produced by pressing on the globe with the finger. It is not visible usually beyond the limits of the disk. The accepted explanation of this phenomenon is dependent upon the fact that the eyeball is a closed cavity, filled with an incompressible fluid, the vitreous humor, and also that the nearer we approach the heart the less is the internal pressure of blood in the veins. When the retinal artery fills with blood, under the impulse from the heart, the retinal vein, in consequence of the transmitted pressure from the vitreous, collapses at its point of exit from the eye, where its resistance is least. This dams up the blood which is constantly filling the vein from the capillaries, until the arterial tension is relieved, when the circulation goes on again until a new arterial impulse is received, and so on. The visible pulsation, therefore, is a mere passive dilatation, which increases with the increase of intra-ocular tension. When the intra-ocular pressure becomes greater than the intra-arterial pressure, as in glaucoma, or valvular insufficiency on the left side of the heart, then the pulsation of the arteries becomes visible on the disk or even beyond.

The only portion of the *choroid* which is visible, in most instances, is the layer of deeply-pigmented hexagonal cells

which lie close behind the retina and probably belong to it physiologically, as they secrete the retinal red. These cells give the stippled or finely granular appearance to the eye ground. If there is very little pigment in the hexagonal cells, as happens in blondes, the superficial capillary layer, the *chorio-capillaris*, is visible in portions of the eye ground. If there is much pigment in the stroma and but little in the hexagonal cells, as sometimes happens, the medium-sized vessels of the choroid are seen, forming a vascular network with dark interspaces all over the fundus oculi. The meshes of the net are nearly round at the disk, but become elliptical at the equator of the eye. In albinos there is an absence of pigment in the hexagonal cells, and even the large vessels of the vasa vorticosæ may be seen.

It is essential for the beginner to become perfectly familiar with the normal eye ground, as seen both by daylight and artificial light, before commencing the study of pathological conditions. By this means many mistakes will be avoided, and dexterity and confidence in the use of the ophthalmoscope acquired.

CHAPTER VI.

REFRACTION AND ACCOMMODATION AND THEIR ANOMALIES.

A double or *bi-convex lens* is one which is convex on both sides, L (Fig. 32). Here the lens is seen in section. Par-

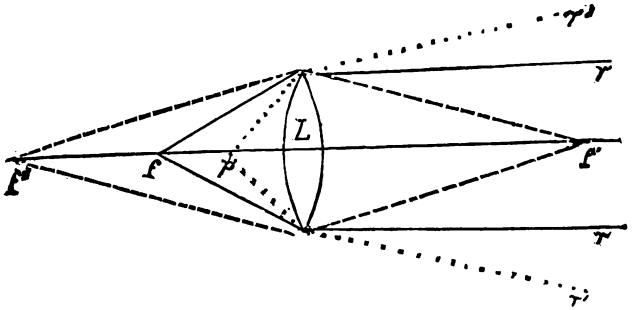

FIG. 32.

allel rays *r r*, coming from an object at infinite distance, after passing through the lens, converge to meet at its *principal focus f*. The ray passing through the centre, however, pursues a straight course. The distance of the principal focus from the lens is called its focal distance. If the object from which the rays arise is brought nearer to the lens, as at *f'*, the refracted rays meet at a point, as *f''*, more distant than the principal focus. If convergent rays, as *r' r''*, pass through, they are made to converge still more, and are focused at a point, as *p*, within the principal focus.

Conversely, rays arising at p would diverge to r' and r''; from the principal focus f would become parallel $r\ r$, and from f'' would converge to f' after refraction. From the interchangeable character of two such points as f' and f'', they are called *conjugate foci.*

A *bi-concave lens* is concave on both sides, as seen in the section L (Fig. 33). Parallel rays $r\ r$ passing through such a lens, become divergent $r'\ r'$. Such divergent rays, prolonged backward, would meet at an imaginary point f, called the virtual focus, the distance of which from the lens is called its focal distance. Conversely, such rays as $r'\ r'$ which, being convergent, would meet at f, become, after refraction, parallel $r\ r$.

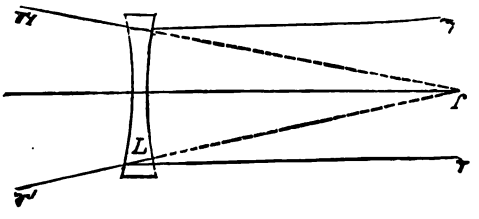

FIG. 33.

There are two systems of lens numeration, for ophthalmological purposes, in use at the present day and as both are frequently alluded to in the literature of the subject, it is necessary to become acquainted with them. The older, which may for convenience be called *the focal system*, is based upon the focal distances of the lenses in inches. A one-inch lens is taken as the unit of measurement, and as all the lenses are of greater focal distance than one inch their refractive power is, of course, less, and is expressed by vulgar fractions, of which one inch is the numerator and the focal distance of the lens in inches the denominator.

For instance, a two-inch lens would have half the refractive power of the unit, and is expressed by $\frac{1}{2}$. Bi-convex lenses, being positive, are denoted by the sign + preceding the fraction, and the bi-concave by the sign —. A bi-convex two-inch lens would, therefore, be $+\frac{1}{2}$; a three-inch lens is + or $-\frac{1}{3}$; a lens of twenty inches focus is $\frac{1}{20}$, and so on. The weakest lens in use is $\frac{1}{72}$. The full series will be given presently, in comparison with those of the newer, which is called the *dioptric system.*

This takes as its unit of measurement a lens of the focal distance of one French meter, and this unit is called one *Dioptry* or *Dioptric.* As the glasses in use are mostly of greater refractive power than the unit, they are mostly expressed by whole numbers. A lens of half a meter in focal distance and, therefore, of twice the power of the unit, is said to be of two dioptries or 2D; of one-quarter of a meter, four dioptries or 4D; and so on, the number of dioptries being always obtained by dividing 100 centimeters by the focal distance of the lens in centimeters, thus, $\frac{100\text{cm}}{50\text{cm}} = 2\text{D}$ and $\frac{100\text{cm}}{25\text{cm}} = 4\text{D}$. As this would make a very incomplete and inefficient series, however, it has been found necessary to piece it out with halves and quarters of a dioptry, which are conveniently expressed in decimals, thus, .5D and .25D.

For purposes of comparison with or translation into the focal system, the series of glasses in dioptries may be expressed in improper fractions; thus one dioptry becomes $\frac{1}{1\text{m}}$; two dioptries become $\frac{2}{1\text{m}}$; three dioptries $= \frac{3}{1\text{m}}$; $1.5\text{D} = \frac{1.5}{1\text{m}}$; $.25\text{D} = \frac{.25}{1\text{m}}$, and so forth. But the French meter is equal to $39\frac{37}{100}$ English inches, or 40 inches in round num-

bers, and $\frac{1}{1m}$, therefore, may be written $\frac{1}{40}$; that is to say 1D $=\frac{1}{40}$ of the focal system; 2D$=\frac{2}{40}$ or $\frac{1}{20}$; 3D$=\frac{3}{40}$ or $\frac{1}{13}$ nearly; 1.5D$=\frac{1.5}{40}$ or $\frac{1}{26}$; .25D$=\frac{.25}{40}$ or $\frac{1}{160}$; and so on.

On the contrary, to convert a lens of the focal system into dioptries, it is only necessary to change the numerator of the fraction which represents the glass from 1 inch to 40 inches, and to reduce to whole numbers or decimals. Thus, $\frac{1}{20}$ would become $\frac{40}{20}$=2D; $\frac{1}{10}$ becomes $\frac{40}{10}$=4D, etc.

It may be said here that the glasses of French manufacture, which are those in general use in this country, although marked for their focal distance in French inches, really correspond almost exactly to the English inch.

The following table shows the series of lenses contained in both the dioptric and the focal systems, and the middle column shows the focal distances of the former in English inches.

Dioptric Series.	Focal Distances of the Dioptric Series in English inches.	Series of the Focal System.	Dioptric Series.	Focal Distances of the Dioptric Series in English inches.	Series of the Focal System.
0.5	80.	72	5.	8.	8
.75	58.	60	5.5	7.	7
		48	6.	6.7	6½
1.	40.	42			6
1.25	32.	36		5.7	5½
1.5	26.	30	8.	5.	5
1.75	23.	24	9.	4.4	4½
2.	20.	20	10.	4.	4
2.25	18.	18	11.	3.6	3½
2.50	16.	16	12.	3.3	3¼
		15	13.	3.	3
		14	14.	2.8	2¾
3.	13.3	13	15.	2.6	
3.5	12.	12	16.	2.5	2½
		11	17.	2.3	
4.	10.	10	18.	2.2	2¼
4.5	9.	9	20.	2.	2

The breaks in each series show where it is defective, as compared with the other. The dioptric system lacks glasses of low power, which are those most needed. The focal system lacks those of high power, which are rarely used, and in which a trifling change in the distance of the lens from the eye will make up the difference in focus.

The advantage of the dioptric system lies in the greater ease with which addition and subtraction can be performed with whole numbers than with the fractions of the focal system.

An advantage of the latter is that we always know the focal distance of the lens we are using without stopping to make a calculation, as is inevitable in using dioptries. Many of the ophthalmoscopes of the present day have the lenses numbered in both systems, and this is also frequently the case with the trial glasses used in testing the refraction and accommodation.

CYLINDRICAL LENSES also are used to correct the refraction of the eye. Such lenses are ground on the inner or outer surfaces of cylinders, and therefore correspond in form on one side to a small portion of such surfaces. They are either convex or concave. Rays which pass through the axis of the cylinder suffer no deviation, but those in planes at right angles to the axis are refracted according to the curvature of the cylindrical surface.

Prisms also are used occasionally. Their refracting angles vary from 2° to 20°.

THE IMAGE ON THE RETINA.—That the refractive system of the eye produces upon the retina an inverted image of an external object has already been stated, but the

mode in which this image is produced has not been explained. It is necessary, however, that this matter should be understood, in order that the solution of the problems of the anomalies of refraction shall be clearly comprehended. From every point of the object B A (Fig. 34) there proceed divergent rays. Of those which emanate from the point B, for instance, two are represented as entering the pupil and becoming focused at *b* on the retina. Of the rays from A two others enter the pupil and are refracted to the point *a*. In a similar manner we may deal with the

FIG. 34.—Mode of Formation of the Retinal Image.

point R, and with every other portion of the object, until it is delineated on the fundus oculi in an inverted position at *a b*.

For rays coming from an object at an infinite distance, and therefore parallel, this focusing upon the retina occurs in emmetropic eyes only. In *hypermetropia* and *myopia* such rays would be brought either to an imaginary focus behind, or to an actual one in front of the retina.

Let the bi-convex lens (Fig. 35) represent the refractive system, and the screen E E the retina of an emmetropic

eye. The parallel rays which impinge on the lens are brought to a focus at *o*. But the hypermetropic eye is a flat eye, and the retina would be placed nearer the lens, as at H H. The parallel rays then could not be focused on this retina, but would form a diffused image at *a b*. From what we already know of lenses, it will be evident that rays must be already convergent as they approach such an eye, in order to be brought to a focus on its retina.

The myope, on the contrary, has a long eye, and the retina is placed beyond the focus for parallel rays, as at

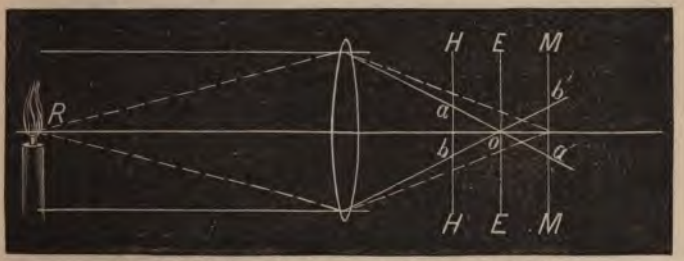

FIG. 35.—Relation of the Focus to the Retina in H. E. & M.

M M. The rays would, therefore, cross at *o* and form a diffused image at *b' a'*. In order that an accurate image should be formed upon this retina, it is necessary that the object should be brought near to the eye, as represented by the candle at R, the rays from which, according to known laws, are focused at the central point of the retina. This point R is the furthest point of distinct vision for such an eye.

Any variation in the refraction from the condition of emmetropia is known as *ametropia*. It, therefore, includes both of the above-named as well as some other anomalies.

THE ACUTENESS OF VISION may be impaired, from a variety of causes. Lack of proper adjustment of the refractive system of the eye is probably the most common, and this must always be corrected by the proper glass before the *actual* acuteness can be measured, although it is well always to note the *apparent* acuteness for future reference. The normal eye becomes less sensitive as age advances, so that at eighty the sight is scarcely more than half as sharp as at ten years of age. Too great an amount of light, as well as too little, interferes with the vision. Disease of any portion of the eye, as haziness of the media, etc., of course, diminishes the visual powers.

Supposing the eye, however, to be healthy and duly adjusted for the test object, acuteness of vision will then depend upon the sensitiveness of the retina. This is measured precisely as is that of the skin, by the nearness to which two points may be approximated and still be distinguished. One point cannot be used as a measure, because its perception depends entirely upon the brilliancy of the light which emanates from it. It has been found that two points, at the most sensitive spot on the retina, must be at least 0.00436 millimeter ($\frac{1}{5760}$ inch) apart, in order to be seen separately. These points correspond to two distant external objects which subtend a visual angle of one minute.

THE VISUAL ANGLE is that included between two lines drawn through the nodal point of the eye to the two opposite outer edges of any object. It is the measure of the apparent size of an object, and a dollar at the proper distance appears as large as the full moon, because it subtends

the same visual angle. In order to measure the acuteness of vision by means of the visual angle, the object is always placed at a distance, or what is called distance in ophthalmology; that is to say, at a point where there is no possibility of the accommodation being brought into action. This is usually taken as anywhere beyond fifteen feet, but a distance of twenty feet is commonly selected, for the convenience of round numbers.

Snellen's test letters are the objects generally used for the purpose of measuring the acuteness of vision. These are block letters, so constructed that the limbs are everywhere of sufficient thickness to subtend a visual angle of 1′ at a distance corresponding to the number of the letter. No. xx, for instance, should be seen at twenty feet, and No. c at a hundred. Theoretically, the spaces between the limbs should be also of the same width; but this obtains in a few letters only, such as **B**, **E** and **S**. Owing to the irregular shapes of the letters, which are in height and width five times the thickness of the limb, they are not, therefore, an accurate test of maximum powers of vision, but are, nevertheless, a fair test of mean visual acuteness for different ages.

In testing the sharpness of sight of an eye, the card of test letters should be hung in a good light, at twenty feet distance, and a black card or screen should be held before the other eye. If the patient can now clearly distinguish the letters of No. xx, the acuteness of vision, or V, $= \frac{20}{xx}$. The numerator of the fraction, usually written in Arabic figures, represents the distance of the test card from the eye, in feet. The denominator, generally written in Roman numerals, gives the numbers of the letters which are read.

If, at twenty feet, the patient sees nothing smaller than No. C, then $V = \frac{20}{c}$. If he cannot read No. CC at twenty feet, the card must be brought nearer until it can be read. If it must be brought to four feet from the eye, then $V = \frac{4}{cc}$.

If the patient cannot see letters at any distance, then it may be ascertained whether he can count fingers held between him and the light, and if so, at what distance, which should be noted accordingly. A lower degree of visual acuteness is determined by the ability to distinguish the kind of light, as to color, etc., which is reflected from any surface; this is known as *qualitative light perception.* The lowest grade of vision, short of blindness, is the power to judge of the difference between light and darkness, or to note when the light is cut off by an opaque screen passed between the eye and the window. This is called *quantitative* perception of light.

No. 1½ or 0.5 m.

A sample sheet of test-letters similar to those devised by Snellen, will be found at the end of this volume.

No. 2½ or .75 m.

A sample sheet of test-letters similar to those devised by Snellen, will

No. 3½ or 1 m.

A sample sheet of test-letters, similar to those devised by

No. 5½ or 1.5 m.

A sample sheet of test-letters similar

No. 8½ or 2.5 m.

A sample sheet of test

Many of Snellen's test-cards at present made are numbered in meters instead of feet, and may be used at a distance of six meters, if the surgeon prefers the metric system. As six meters are practically twenty feet, however, the distance will remain the same, but the result must be stated, in both parts of the fraction, in meters.

THE RANGE OF ACCOMMODATION.—The manner in which the eye accommodates itself for near objects has already been explained (page 20), and the changes in refraction which are involved must be apparent from what has been said before of the properties of lenses. The furthest point of distinct vision is called the *punctum remotum* (*r*). The nearest is the *punctum proximum* (*p*). The distance between the two is the range of accommodation (A). The distance of *r* from the nodal point of the eye may be represented by R, and the distance of *p* by P. For convenience we may represent these last three values by convex lenses of corresponding focal distances. Then $\frac{1}{A} = \frac{1}{P} - \frac{1}{R}$. But in an emmetropic eye R is equal to infinite distance, and P is readily found by ascertaining the nearest point at which the finest print can be clearly read. If this should be at six inches distance, then $\frac{1}{A} = \frac{1}{6} - \frac{1}{\infty} = \frac{1}{6}$.

That is to say, an emmetropic eye whose near point is at six inches, will, by means of a $+\frac{1}{6}$ lens, receive rays coming from *p* as if they came from *r*, or were parallel.

The accommodation may be measured with a concave glass also. Such a lens makes parallel rays divergent; hence, the strongest glass with which an emmetropic eye can see distant objects distinctly will make parallel rays enter such an eye as if they came from its near point.

The range of accommodation for hypermetropia or myopia may be measured by first correcting the ametropia by a suitable lens, and then, after finding P by this glass, using the above formula.

Or the accommodation in myopia may be found by the formula without using any glass. If P = 4 in. and R = 8 in., then $\frac{1}{4} - \frac{1}{8} = A\,\frac{1}{8}$.

A ready method adapted to nearly all cases, and one which reveals myopia or hypermetropia as well as the accommodation, is to place before the eye under examination a convex $\frac{1}{10}$ which brings the far point within easy range. The eye should then be tested as to the nearest and furthest point at which it can read fine print (No. 1 Snellen). The emmetropic eye, with this glass, should, of course, read at 10 inches as far point, for rays coming from 10 inches would enter the eye parallel, as if they came from infinite distance. If the near point, with the same glass, is at 3 inches distance, then the same formula applies, and $\frac{1}{3} - \frac{1}{10} = \frac{1}{4\frac{1}{2}}$.

The P and R found with such a glass may be designated as P′ and R′. If P′ = 4 in. and R′ = 12 in., then $\frac{1}{4} - \frac{1}{12} = A\,\frac{1}{6}$. But this eye must be *hypermetropic*, because it sees beyond the normal far point, which, for this glass, is 10 in.

If we should find P′ = 3 in. and R′ = 8 in., then $\frac{1}{3} - \frac{1}{8} = A\,\frac{1}{24}$, and the eye is *myopic*, because it cannot see up to the normal far point.

If the surgeon prefers to work in dioptries, P and R or P′ and R′ must be taken in centimeters. If we use the same distances as those in the last example, then 3 in. = 7.5 cm., and 8 in. = 20.5 cm. The dioptric equivalent of $P' = \frac{100\text{cm.}}{7.5\text{cm.}} = 13D$, and that of $R' = \frac{100\text{cm}}{20.5\text{cm.}} = 5D$. Then the

formula A=P—R applies as before, and A=13D—5D =8D. The same method may be used with all the foregoing examples.

In all the above examples the *absolute* accommodation for each eye is obtained. If the two eyes are tried together the *binocular* range will be obtained, the same formula being used.

The *relative* range of accommodation is that which we possess while the eyes are fixed upon a given point. The *positive* portion is that lying on the near side of the point of convergence, and the *negative* portion is that lying beyond. The former may be measured by concave, the latter by convex glasses. To read comfortably for any length of time at a given distance from the eyes, the positive portion of the relative range of accommodation must be at least one-half of the negative.

PRESBYOPIA is the name given to that failure of the accommodation which accompanies middle life and old age. It is the result of a gradual hardening of the crystalline lens, which thus becomes less capable of undergoing the changes in form necessary to near vision. In the emmetropic eye the near point commences to recede at the age of ten years, when P=2¾ in., and goes on increasing its distance from the nodal point during the remainder of life. After the age of fifty the far point also recedes progressively with advancing years, and the individual becomes hypermetropic in consequence of permanent flattening of the lens. The most recent diagram of curves constructed by Professor Donders, of Utrecht, and showing the progressive failure of accommodation and the increase of acquired

hypermetropia in the originally emmetropic eye, affords the data for the following table: —

Age.	Range of Accommodation.		Acquired Hypermetropia.	
	Focal System.	Dioptric System.	Focal System.	Dioptric System.
40	1 : 9	4.5		
45	12	3.5		
50	16	2.5		
55	24	1.75	1 : 160	.2
60	40	1.	120	.33
65	60	.75	60	.70
70	160	.25	30	1.25
75	0	0.	24	1.75
80			18	2.30

Donders considers that presbyopia has commenced as soon as the near point is further than eight inches from the eye. If this were always true then it would be easy to calculate the amount and to prescribe the proper glass to bring p back to eight inches. But this point is an arbitrary one and has little or no practical value. We may say that presbyopia has commenced whenever the individual finds that, from failure of the accommodation, he can no longer use his eyes comfortably for near work at the distance which has become habitual to him. This condition obtains as well with ametropia as with emmetropia, provided the former is corrected by appropriate glasses. With a myope of high degree, for instance $\frac{1}{8}$, presbyopia would be relieved by laying aside the correcting glasses.

The first symptom of presbyopia is usually that the individual cannot see to read fine print by artificial light without difficulty. Afterward there comes on a sense of strain in using the eyes for near work at all times. This feeling of strain is due to the over-exertion of the ciliary muscle in

the effort to produce the required amount of convexity in the crystalline lens. There is a popular idea that this discomfort should be borne as long as possible, and that the eyes are weakened by early measures taken to relieve the strain. The reverse is true, however, and presbyopia is found to increase more rapidly when glasses are not worn than when the proper correcting lens is used.

In prescribing glasses for presbyopia, we must take into account the distance at which it is habitual and convenient for the individual to use his eyes, and the kind of work for which he employs them. All this varies very much for different persons, and even the stature of the presbyope has its influence in determining the distance at which reading, writing, sewing, etc., are convenient. A small woman often wants to hold her fine needlework at eight or ten inches from the eye, but a tall man is uncomfortable with his book nearer than eighteen or twenty inches.

Only an approximation to the proper glass can be found by calculation, and actual trial must determine whether comfort or discomfort is to follow the use of certain spectacles. If the near point is found to be at twenty inches, and it is desirable to use the eyes at twelve inches, then $\frac{1}{12} - \frac{1}{20} = \frac{1}{30}$; but before prescribing $\frac{1}{30}$ the relative accommodation should be tested with it at twelve inches, to ascertain if the positive is at least one-half of the negative accommodation at that point, and the strength of the glass should be increased or diminished, as the case may be.

The presbyopia of ametropia must be relieved in the same way, the near point being obtained while the proper correcting glasses for the ametropia are worn. In hyper-

metropia the presbyopic glass must be added to that suitable for the correction of the ametropia. In myopia the concave glass must be subtracted from the presbyopic one.

A person of fifty years of age, who is hypermetropic $\frac{1}{24}$, and who is habituated to work at twelve inches from the eyes, would require $\frac{1}{12} - \frac{1}{18} = \frac{1}{36}$, and $\frac{1}{24} + \frac{1}{36} = \frac{1}{14.4}$, the glass needed. The $\frac{1}{18}$ here used in the first calculation is obtained from the second column of the table of ranges of accommodation given above; but, although this answers in most cases, in order to arrive very near to the proper glass required, the result must always be tested and, if necessary, rectified by actual trial.

Myopes, whose acuteness of vision is often not equal to the normal standard, generally prefer a working distance of eight or nine inches. A myope of $\frac{1}{8}$ would then require $\frac{1}{8} - \frac{1}{8} = -\frac{1}{18}$ as a working glass up to the age of sixty-five, when the refraction is liable to diminish. A myope of $\frac{1}{48}$, at fifty years of age, if accustomed to work at eight inches, would require $\frac{1}{8} - \frac{1}{18} = \frac{1}{18}$, the glass needed for emmetropia, and $\frac{1}{18} - \frac{1}{48} = \frac{1}{24}$, the convex glass needed for the myope.

The foregoing problems may be solved equally well in dioptries. If we take the last, there is no dioptry which corresponds to $\frac{1}{48}$ or 120 cm. focus; but we may use the nearest, which is 0.75D, or 133 cm. focus; and for 8 in. use 20 cm.; for 16 in. use 40 cm. Then 5D — 2.5D = 2.5D, and 2.5D — 0.75D = 1.75D, the glass required

It is essential not to mistake the failure of accommodation due to disease for normal presbyopia. One of the earliest symptoms of glaucoma is the rapid loss of the accommodation. This symptom may occur also from paresis

of the third cranial nerve, which often accompanies paralysis of the external rectus muscle. Every case of apparent presbyopia must, therefore, be carefully inquired into before we can rest satisfied that glasses merely are required.

PARALYSIS OF THE ACCOMMODATION causes the same impairment of vision as marked presbyopia. It is generally accompanied by dilatation of the pupil, and may, by this symptom alone, be differentiated from presbyopia, in which the pupil is contracted. The affection often occurs in one eye only, and all the parts supplied by the third cranial nerve are frequently involved. In some instances, however, the ciliary muscle alone is affected. The disorder may result from cerebral or constitutional causes, as diphtheria and syphilis, or it may be of reflex origin from chronic suppurative ear disease, or from irritation occasioned by the teeth. The treatment must be directed to the cause, but temporary relief may sometimes be obtained by the instillation of a collyrium of eserine sulphate, gr.j ad f℥ij, or by wearing appropriate convex glasses.

SPASM OF THE ACCOMMODATION sometimes occurs in emmetropic eyes from forced work in a dim light, causing the patient to appear myopic. It happens in all degrees of ametropia, and sometimes simulates myopia even in hypermetropes. It causes pain, a feeling of tension in the eyes, and an uncertainty in the location of the far point. The instillation of a solution of atropia sulphate, gr.j ad f℥ij, one drop three times a day, in the conjunctival sac, until the condition of the refraction is settled, confirms the diagnosis and relieves the spasm. *Myosis*, or abnormal contraction of the pupil, often accompanies this condition, but may occur without it, owing to paralysis of the sympathetic.

HYPERMETROPIA has already been described (page 97) as a condition of refraction, which, when the eye is at rest, allows convergent rays only to be focused on the retina. The accommodation must be used to focus parallel rays, and still more to focus the diverging rays which come from a near object. In consequence, the eye is seldom at rest, the accommodation is always in use, and a certain amount of contraction of the ciliary muscle becomes a constant quantity which cannot be relaxed by the volition.

The strain on this muscle, from the frequent demands of near vision, is so great that a condition of weak eyes, or *accommodative asthenopia,* is frequently developed. This is characterized by the fact that when the patient commences to read or write, etc., the vision is at first perfectly clear; but soon the letters commence to run together, the sight becomes blurred, and it is necessary to stop work for a few minutes, until the eye regains its power. If the use of the organ is persisted in, a feeling of strain and aching arises in the brow, often followed by severe headache, the eyes sometimes become red and suffused and the tarsal conjunctiva hyperæmic, nausea and vomiting may supervene, and the patient is not infrequently supposed to be suffering from disease of the brain.

The development of this condition of asthenopia appears to depend greatly on the degree of irritability of the nervous system of the individual. Some persons with much hypermetropia suffer merely from the early appearance of presbyopia, or from indistinct vision. In other instances convergent squint is developed, as will be explained in a subsequent chapter.

Hypermetropia usually depends on a flatness of the eye; which is too short in its axis, or antero-posterior diameter. This condition is congenital, and is often accompanied by a certain flatness of the face, especially about the malar prominences, which leads to a recognition of the difficulty before an examination of the eye is made. The trouble may result, however, from a flattening of the cornea, the effect of disease; but the highest degree follows the extraction of the lens, as after cataract operations. In congenital hypermetropia the visual axis deviates more to the nasal side of the optic axis than in emmetropia, often giving rise to an apparent squint. Hypermetropia is often accompanied by astigmatism, or by lessened acuteness of vision (*amblyopia*) which seems to be congenital.

An easy method of diagnosis of hypermetropia (H) is by ascertaining whether the patient can see beyond the focus of a convex lens (page 102). If, for instance, $+\frac{1}{10}$ is used, and the patient can read distinctly therewith at 20 inches, then $\frac{1}{10} - \frac{1}{20} = \mathrm{H}\,\frac{1}{20}$. Or, his vision may be tested on distant objects, as Snellen's test-letters at twenty feet, and if improved, or not impaired by convex glasses, it is evident that this defect of the refraction exists. The strongest convex lens with which the patient can see distant objects distinctly gives the measure of the amount of accommodation which can be voluntarily relaxed, and is called the manifest hypermetropia (Hm). To obtain full suspension of the accommodation, it is nearly always necessary, except in presbyopes, to instill one or more drops of an eight-grain solution of atropia sulphate in the eye. The convex lens which gives the best vision under these circumstances measures the total hypermetropia (Ht.) The dif-

ference between the total and the manifest is called the latent hypermetropia (Hl).

But the quickest means of diagnosis is with the ophthalmoscope. If the mirror be used, without a lens, at a distance of 18 in. or 2 ft. an erect image of the fundus will be seen; which will move in the same direction, to either side, as the head of the observer. To measure the degree of hypermetropia the observer, if emmetropic, must learn to relax his accommodation. This is done by practice with a convex lens, trying to see distinctly at its focus, at the same time endeavoring to keep up the illusion that

Fig. 36.

the eye is fixed on some object in the distance. If the observer is ametropic, a suitable correcting glass should be worn, or must be allowed for in the result of the ophthalmoscopic examination. If the eye of the patient is now fully under the influence of atropine, the strongest convex lens with which the fundus can be distinctly seen in the erect image at a little more than half an inch distance, gives the total hypermetropia.

The rays from *a*, in the eye under examination, H (Fig. 36), emerge divergingly, as though they came from R, but are made parallel by the lens, L, and thus brought to a focus, *b*, on the retina of the emmetropic eye E.

If the fundus is distinctly seen, and will not bear a con-

vex lens, then the patient is emmetropic. If the observer is myopic $\frac{1}{24}$ and can use as high as $+\frac{1}{24}$, with the ophthalmoscope on the patient, then is the ametropia of the latter $\text{Ht} = \frac{1}{12}$. If the observer is hypermetropic $\frac{1}{24}$ but can voluntarily relax to $\frac{1}{48}$ only and can use $+\frac{1}{12}$ on the patient, then is the refractive defect of the latter $\frac{1}{12} - \frac{1}{48} = \text{Ht}\,\frac{1}{16}$. The determination of the refraction should be made upon the small vessels in the neighborhood of the macula, or of the outer edge of the disk, as there is little or no difference of level between these two points. The large vessels of the disk are unsafe guides.

The accommodation of the patient may be relaxed in many cases, without the use of atropia, by making the examination in a dark room and causing the hypermetrope to look at the most distant object possible. The refraction must then be measured by the small vessels at the outer edge of the disk.

If the ophthalmoscope is held sufficiently close (half an inch) to the observed eye, the convex lens used will give the degree of hypermetropia; but if an inch or more intervenes, the distance from the anterior nodal point of the examined eye (half an inch in front of the cornea), to the ophthalmoscope must be deducted from the focal distance of the lens. Thus, if the instrument shows the patient to be hypermetropic $\frac{1}{6}$ and the ophthalmoscope is held at $1\frac{1}{2}$ inches from his eye, then $6 - 1 = 5$ and the defect in refraction is $\frac{1}{5}$.

The treatment is conducted with most comfort to the patient when the range of accommodation is great, if lenses which correct the manifest hypermetropia only are first

prescribed. These may give some annoyance by making things appear larger than natural, and in this case a weaker pair should be substituted. The object is to find by trial the spectacles which relieve the asthenopia and give the greatest ease and comfort, and it is often not necessary to know the Ht in order to do this. Very few persons can bear, without much annoyance, to have their total hypermetropia corrected at once. As soon as the effects of the atropia pass off the latent hypermetropia usually returns, even though the correcting glasses are worn all the time. If a pair of spectacles be prescribed at first, to neutralize the Hm only, or even weaker, they will be found so comfortable that the patient will soon wear them constantly, of his own volition. They will soon prove to be too weak, and a stronger pair may be substituted, and the full correction may be reached in two or three changes in this way, without the inconvenience and loss of time attendant upon the use of atropia.

If the hypermetropia is *absolute*, that is to say, if it is greater than the range of accommodation, glasses must be prescribed at once, for constant wear. These should generally, at first, be equal to the Hm.

If the hypermetropic patient is at the same time presbyopic, the divided spectacles introduced by Franklin may be worn. Each glass is divided into two lenses, the upper, for distant vision, corrects the hypermetropia; the lower, for near work, relieves the presbyopia also. To avoid the odd appearance of the dividing line, the two lenses are sometimes ground on one glass. These are the *verres à double foyer* of the French opticians.

When the asthenopia is persistent it is sometimes, though rarely, necessary to correct the Ht and to keep the eyes under the influence of atropia for several weeks.

MYOPIA has already been described as a condition of the eye in which divergent rays only, coming from a near object (R, Fig. 35, page 97), can be brought to a focus on the retina. This difficulty usually arises from the posterior portion of the eye being pushed too far away from the anterior, so that there is an elongation of the axis of the organ; in bad cases, the eye, instead of being round, becomes egg-shaped. The sclera in the vicinity of the optic nerve becomes attenuated, so that the color of the choroid shows through it, and this thinning may even extend in front of the equator. The choroid about the nerve entrance atrophies, its pigment is absorbed and its vessels obliterated. The stretching of the sclerotic pulls the outer sheath of the nerve away from the inner, leaving a space between them, into which the thinned sclera slightly sinks, forming the so-called posterior staphyloma. The nerve is pushed more to the nasal side of the eye, and further from the macula, and finally the tension of the choroid is increased by the displacement of the nerve to which it is attached, and the iris is drawn slightly backward.

The symptoms are due to the approximation of the far point to the eye. There is an inability to discern objects in the distance, a necessity to hold the book, etc., inconveniently close, and often there is considerable muscular asthenopia, owing to the strain on the internal recti muscles during forced convergence. This produces pain about the eyes, headache, congestion of the lids and ball, and a feeling

of ocular fatigue. The oval shape of the eye makes it more difficult to obtain binocular vision by convergence of the visual axes, and this trouble is increased by the visual axes being more inclined outward, toward the optic axes, than in emmetropia. In consequence, when the myopia is great, the effort is abandoned and the eyes are used singly for near vision, with, perhaps, the production of divergent strabismus. The distention of the sclera and choroid affects also the retina, the rods and cones are stretched further apart than normal, and the acuteness of vision diminished. If the disease is progressive the vitreous becomes disorganized, the vision is interfered with by floating shreds, and the lens may become cataractous, especially at the posterior pole.

The diagnosis is readily made by testing the far and near vision. If the patient cannot see distant objects, and can read No. 1½ Snellen perfectly well, but not beyond 10 inches, it is evident that this is his punctum remotum, and that he is myopic $\frac{1}{10}$. A concave $\frac{1}{10}$ placed in front of such an eye would cause parallel rays to be divergent, as if they came from only 10 inches away, and would thus make distant objects distinctly visible. The degree of myopia may be measured by the weakest concave lens with which letters can be clearly read at 20 feet. If the glass can be moved away from the eye, and the vision is not impaired, then the lens is too strong, for otherwise the virtual focus would be moved beyond the punctum remotum.

Or, by the method mentioned on page 102, if $+\frac{1}{10}$ is placed before the eye and the patient therewith cannot read beyond 5 inches, then $\frac{1}{5} - \frac{1}{10} = \text{M}\,\frac{1}{10}$.

But the ophthalmoscope also affords a ready means of diagnosis. If the mirror is used without a lens, at 18 in. or 2 ft. from the patient, and the far point of the examined eye is less than these distances, then an inverted image of the fundus will at once be seen, and if the head is moved from side to side the ophthalmoscopic picture will always move in the opposite direction. This is owing to the crossing of the emergent rays at the punctum remotum before they meet the eye of the observer.

If the mirror is now brought close to the patient's eye, the weakest concave lens which will show the little vessels near the macula, or between it and the disk, gives the degree of the myopia. Any stronger glass than this merely brings the accommodation of the observer into action. This will be made evident by a glance at Fig. 37.

Fig. 37.

Here the rays from *a* leave the myopic eye M so convergingly that they would meet at its far point R. But the concave glass L makes them parallel before they impinge upon the relaxed eye E of the observer.

The change in the eye ground, usually seen with the ophthalmoscope, is a patch of choroidal atrophy adjoining the optic nerve. This patch is mostly crescentic, and lies

on the side of the disk toward the macula, but it may lie on other sides, and is sometimes even annular. On account of the absorption of the choroidal pigment and vessels, the white sclerotic is apparently laid bare, but the retinal vessels still course over the atrophied spot. In cases of myopia which are stationary, the outer edge of the crescent is marked by a firm, black line; but if the disease is progressive this line is absent, and the hexagonal cells near the margin are evidently undergoing absorption. The disappearance of the epithelium may sometimes be noticed close to the edge of the disk in the early stages of myopia, before the choroidal atrophy is complete, or in some cases of this kind a few choroidal vessels only are left. It is often difficult to make out clearly the outlines of the nerve in cases when the posterior staphyloma is large, but the disk is always of a more rosy tint than the patch of atrophy. If the myopia increases, and especially as age advances, the atrophy spreads, detached spots appear outside of the main body, the macula is threatened and even attacked, patches of inflammation and hemorrhage appear and spread, perhaps to the equator, the vitreous becomes involved, opaque shreds of tissue float about in the broken-down humor, and detachment of the retina with blindness may close the scene. These changes constitute the condition known as *sclero-choroiditis posterior*.

Although it is not quite settled whether myopia is much more than exceptionally congenital, there is no doubt that the predisposition to it is often inherited. Even hypermetropia apparently favors its development under certain conditions. Constant straining of the eye, to see in un-

favorable circumstances, especially if the tissues are weak, seems to be the general cause of the disorder. Such circumstances may be an impairment of the transparency of the refractive media; for instance, spots left by ulcers on the cornea; very fine work or bad print, and defective illumination. Improper arrangement of the light in schools, and too much study, claim more myopic victims than all other causes. Statistics show that the percentage of cases increases with every year of school life. If from any of the above named causes vision is imperfect, the book is brought near to the eye, in order to enlarge the retinal image; this involves strong convergence of the optic axes, to maintain which the accommodation is spasmodically brought into play, irritation and congestion of the ocular tissues follow, and passive hyperæmia is added by the pressure in the cervical veins caused by the bending down of the head. That weakness of the tissues is often a necessary factor in the production of the disease, is shown by the frequency with which myopia arises in children after a severe illness, and also that it generally ceases to progress after the age of twenty-five, when the tissues commence to acquire the firmness of maturity.

The treatment must be based on the fact that the myopic eye is a weak eye, notwithstanding the popular belief to the contrary. The first thing to be done is to find out the exact amount of the myopia, and it is probably best, in nearly every case, to first bring the eye fully under the effects of a mydriatic, in order to dislodge any lurking spasm of the accommodation. A drop of a solution of atropia sulphate, grs. iv ad f℥j, placed in the conjunctival sac answers

well for this purpose, as we are in no hurry usually to have the patient return to near work. The drop may be repeated two or three times a day for several days, if necessary, until we are satisfied that the ciliary muscle is thoroughly relaxed. If, during this period, the refraction is tested every day the myopia is often found to diminish as the influence of the atropia increases.

Should the myopia be slight and of recent origin, or should it be progressive, of any degree, its progress may be stopped, and in recent cases an apparent cure effected, by keeping the eyes under the influence of atropia for some length of time, while for reading, or any near work, a glass is worn, which sets the far point at about fifteen inches. If the myopia were only $\frac{1}{30}$ this would require $\frac{1}{15} - \frac{1}{30} = + \frac{1}{30}$, or convex $\frac{1}{30}$ for the purpose. But if the myopia is $\frac{1}{7}$ then $-\frac{1}{7} + \frac{1}{15} = -\frac{1}{13}$, or concave $\frac{1}{13}$ would be the glass needed. Few persons, however, are willing to submit to this treatment, except progressive myopes of high degree, and others do not, as a rule, apply for treatment in the early stages of the affection.

Should the person be young, *i.e.*, the system not fully developed, the myopia apparently fixed and the acuteness of vision as determined by the proper concave lens equal, or nearly equal to normal, it is best to prescribe at once the correcting glass for distance and let it be worn constantly. As the myope has always been obliged to use his convergence, and at the same time to try to suppress his accommodation, as much as possible, in reading or near work at his far point, these two functions, which naturally work together, are, to the great impairment of the latter, brought into op-

position. Hence, it will often be several weeks before the ciliary muscle regains sufficient strength to make the wearing of such glasses comfortable, and in the meantime, reading, or any continued strain for near work should be avoided, or adopted gradually as the eye becomes fitted for it. The myope must be instructed not to bend over his work, never to work by a dim light, to keep his book up in front of him, in his hand, and as far off as is comfortable, to have the light, in writing, shine on the paper from the left side, and never to allow himself to bring his eyes nearer than is absolutely necessary to the object under examination. If the correcting glasses be worn under these conditions, which should be observed, indeed, in all cases of this defect, the myopia will tend to decrease, rather than increase, and the patient will get the benefit of accurate vision of distant objects, which is of the greatest importance in the education of the faculty of observation.

If the myope is too old to allow of the cultivation of the accommodation, and the myopia is fixed, then the treatment must depend upon the degree. If less than $\frac{1}{20}$, correcting glasses for distance only, should be prescribed. If between $\frac{1}{20}$ and $\frac{1}{8}$ or $\frac{1}{8}$ the full correction may be worn, if the actual range of accommodation will bear it. If not, or if the myopia is higher than $\frac{1}{8}$, then two pairs of glasses must be prescribed, one being the correction for distance, the other adapted for near work, at from 10 to 18 inches, according to circumstances. For instance, if the patient has a myopia of $\frac{1}{8}$ and wishes to write at 12 inches then $-\frac{1}{8}+\frac{1}{12}=-\frac{1}{24}$, which would probably be the glass required. If the myopia is slight and the patient presbyopic,

he may wear divided glasses, with concave lenses above for distant, and convex below for near vision.

If the oval form of the eye interferes with convergence, little can be done except by glasses for the relief of this symptom. But if the external recti are evidently too strong, tenotomy of the muscles may be performed. If inflammatory disease of the choroid and vitreous comes on, it must be treated by rest, atropia, counter irritation, etc. If the myopia depends upon imperfect transparency of the refractive media, but little advantage can be gained by the use of glasses, and the patient must try to prevent his eyes becoming worse, by using them as little as possible.

ASTIGMATISM.—This is an abnormal deviation in refraction, which derives its name from the fact that the eye cannot see a point as a round dot, but sees it more or less spread out and diffused in one of its diameters. This is one of the most frequent causes of amblyopia, and must be clearly understood in order to treat disorders of the eye efficiently. It is divided into two kinds, the *regular* and *irregular*. The former depends upon the difference in the refraction of different meridians of the eye. For instance, the horizontal meridian may be emmetropic and the vertical either myopic or hypermetropic; or the eye may be hypermetropic, but one meridian more so than the rest, etc. Indeed, there is almost no eye that is not somewhat astigmatic. Even the emmetrope can generally see a vertical line further away than a horizontal one, although the reverse may be the case.

From a luminous point rays diverge in all directions. If we suppose a cone of such rays, having the pupil of the

astigmatic eye for its base, to impinge upon the cornea, then, if the horizontal meridian is emmetropic, all the rays in the horizontal plane would be reunited in a point on the retina. But if the vertical meridian is either myopic or hypermetropic the rays in the vertical plane would be reunited in front or behind the retina, and form thereon a vertical diffused image. The same principle applies to the refraction of a line, which is merely a succession of points. If a vertical line is to be seen distinctly by the eye under examination, it is necessary that all the rays which diverge in horizontal planes, from every point in the line, should be reunited in points on the retina. Those rays which diverge in the vertical plane are of no consequence, as they may form diffusion images, which cover one another. And so with lines in any direction, the rays which diverge from them in planes at right angles to their lengths must be accurately focused; the others do not affect the definition of the line on the retina. On this fact is based most of the tests for astigmatism.

If a person with this defect wears ordinary spherical glasses, he usually holds his head to one side and looks obliquely through them. In reading, he focuses the vertical limbs of the letters, as these are the principal parts, but in his efforts to see, at the same time, the horizontal limbs, he puts a violent strain upon his accommodation, which causes great asthenopia, with the symptoms heretofore described.

Astigmatism generally depends upon asymmetry of the cornea, which is more convex in one meridian than in the opposite, as is also the case with the bowl of a spoon. The

defect is often accompanied by some asymmetry of the face, generally affects both eyes, is mostly congenital and frequently hereditary. It accompanies hypermetropia in about one-sixth of all cases of that anomaly. In fifty per cent. of all cases of astigmatism the greatest curvature is in the vertical meridian of the cornea, which may, possibly, be owing to the pressure of the lids of the half-shut amblyopic eye, in the effort to obtain accurate vision. Astigmatism frequently follows the extraction of cataract and the operation of iridectomy, from the slight retraction of the corneal wound. It often accompanies dislocation of the lens.

There are three kinds of regular astigmatism. 1. Simple. In this the eye is emmetropic in one meridian and myopic (Am), or hypermetropic (Ah) in that at right angles to the first. 2. Compound. This is of two kinds. Compound myopic (M + Am) and compound hypermetropic (H + Ah). 3. Mixed. In this case the eye is myopic in one meridian and hypermetropic in the other.

There are numerous methods of making the *diagnosis* of astigmatism and of determining its degree, but those commonly used are the best and quickest. If the patient's acuteness of vision is less than $\frac{20}{xx}$, a glance with the ophthalmoscope will show whether he is myopic or hypermetropic. If he is astigmatic the optic disk will, in the erect image, be less defined on two edges than on the two at right angles, or the disk may be unduly oval. These appearances would be reversed in the inverted image. But the retinal vessels give us the best tests in the erect image. As these vessels run in all directions we may by means of

them measure the refraction of different meridians, whether myopic or hypermetropic, and the degree.

Or, without using the ophthalmoscope, we may proceed at once to test the eyes separately, for M or H, with concave, or convex lenses. If we cannot bring the vision to $\frac{20}{xx}$ we may test for As. by means of lines placed at all angles, as in Figs. 38 and 39, or by the twelve letters of Dr. Pray, each one of which is made up of parallel lines, which differ

Fig. 38.

Fig. 39.

from those in the next letter by an angle of 15°. If now, with the test lines at a suitable distance, the patient can see lines in one direction more distinctly than those at right angles to them, he is probably astigmatic.

To determine this point to a certainty, however, the eye must be thoroughly relaxed with atropia, or some other mydriatic. Three drugs are in general use, for this purpose, each having its advantages and disadvantages. They are all annoying, from the glare of light they admit to the eye, and,

except when there is considerable myopia, by preventing the patient from reading, writing etc. Cases often resist their action, and the solutions must be used, a drop at a time in the conjunctival sac, at regular intervals, until the accommodation is quite relaxed. By pressing the finger against the nose at the inner canthus for several minutes after a drop is put into the eye, the tear duct may be closed and the drug prevented from affecting the system. No hard and fast line can be laid down for the action of the mydriatic on the eye in all cases, as the effects vary according to the amount of spasm of the accommodation, conditions of the tissues, age, and strength of the patient, etc. The average action is as follows: *Atropia sulphate*, gr. j ad f℥ij, one or more drops; paralysis of accommodation in one and a half or two hours; lasts a day, but does not disappear entirely for two weeks; may produce symptoms of belladonna poisoning in a slight degree. *Duboisia sulphate*, gr. j ad f℥ij, one or two drops; full effect in an hour; lasts about six hours; influence disappears in a week; may produce vertigo. *Homatropin. hydrobromate*, gr. ij ad f℥j, one to six drops; full effect in an hour; lasts an hour; eye returns to normal condition in one to three days.

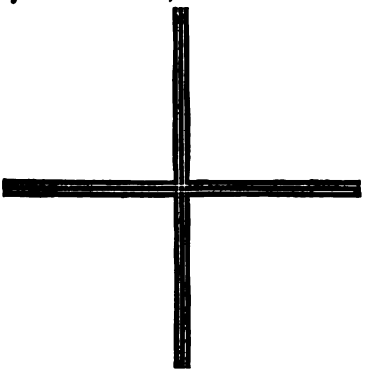

FIG. 40.

Many cases of apparent astigmatism resolve themselves,

when the accommodation is relaxed, into simple H or M. But if, with the best correcting lens, or with the naked eye, the patient still sees lines in one direction more distinctly than those at right angles, he is astigmatic. The lines seen best give the principal meridian of least refraction. Green's test lines (Fig. 40) are designed to be printed on a circular card and to revolve on a central pivot in either of the other figures. (The above diagrams are miniature copies of tests which are intended to be seen at twenty feet distance. These and other tests may be obtained of Messrs James W. Queen & Co., Opticians, of this city.) One group of three lines must be set in the meridian of least refraction, and the proper glass found which gives the best definition. The three lines at 90° to the others are then tried with lenses in the same manner. The difference between the two lenses gives the amount of astigmatism.

The miniature tests also may be used. The accommodation should be thoroughly relaxed, and if the eye is not at all or insufficiently myopic, it should be made highly so with a $+\frac{1}{10}$ lens. The greatest distances in inches at which the lines in the principal meridians can be distinctly seen will then give, by the method of calculation heretofore described (pages 109 and 115), the refraction for those meridians.

Another method is by means of the stenopaic slit. An opaque disk is used which has a slit in it of about the $\frac{1}{10}$ of an inch in width. The disk should be placed in a trial frame before the eye, with the slit at an angle corresponding to and isolating the meridian of least refraction, and the proper lens found which gives the best correction at

twenty feet, for test letters and radiating lines. The slit is then turned 90° and a fresh correction made. The difference between the two lenses gives the amount of astigmatism as before.

If the horizontal meridian is emmetropic and the vertical myopic $\frac{1}{24}$, then the case is one of simple myopic astigmatism (Am) and would be corrected by a concave cylindrical lens $\frac{1}{24}$ with the axis placed horizontally. The prescription for such a glass would read thus $-\frac{1}{24}$ c axis 180°.

If the meridian at 10° from the horizontal is H = $\frac{1}{48}$ and that at 100° is H = $\frac{1}{12}$, then $\frac{1}{12} - \frac{1}{48} = \frac{1}{16}$. This is a case of H + Ah, and the full correcting glass would be $+\frac{1}{48}$ spherical combined with $+\frac{1}{16}$ cylindrical; thus $+\frac{1}{48}$ s ⊃ $+\frac{1}{16}$ c axis 10°.

If the meridian at 45° = H $\frac{1}{24}$ and that at 135° = M $\frac{1}{48}$, then the case is one of mixed astigmatism, and the full correcting glass would be $-\frac{1}{48}$ s ⊃ $+\frac{1}{16}$ c axis 135°; for if all the meridians are made myopic $\frac{1}{48}$, then the hypermetropic one would require $\frac{1}{24} + \frac{1}{48} = \frac{1}{16}$. Or, two cylindrical glasses may be used, with their axes at right angles, thus $+\frac{1}{24}$ c axis 135° ⊃ $-\frac{1}{48}$ c axis 45°.

When the proper correction has been found all the radiating lines of Figs. 38 or 39 will look equally black and distinct. If the astigmatism is simple, the full correction may be prescribed at once, and may be worn either for reading or for distant vision. If compound, we correct the astigmatism, but as to the H and M must be governed by the principles laid down heretofore (pages 112 and 118). If mixed, the full correction should be given for distance, and that for near vision must be

governed by circumstances, as before. If there is much amblyopia, the weakest glass, either plus or minus, which gives the best vision, should be prescribed.

The optician grinds the combinations of lenses on one glass and sets it at the proper angle in an ordinary spectacle frame. Or, eye glasses may be used; but these are objectionable on account of the liability of the cylinder axis to be displaced.

IRREGULAR ASTIGMATISM depends upon a difference in the refraction of different parts of the same meridian of the eye. It sometimes causes two or more images in one eye, or *monocular polyopia.* It arises from irregularities in the cornea or in the structure of the lens. The emmetropic eye has a certain amount of irregular astigmatism dependent upon slight variations in the different sectors of the lens. It is for this reason that luminous points, such as the fixed stars, appear not round but radiated. In irregular astigmatism the vision may be improved by looking through a stenopaic hole, about $\frac{1}{16}$ inch diameter. This will limit the rays to uniform portions of the refracting media.

ANISOMETROPIA is a term applied to cases where the refraction of the two eyes is unlike. If one eye is myopic and the other emmetropic, the former is used for near the latter for distant vision. It is not advisable to prescribe glasses in such a case. If both eyes are ametropic the one which gives the best vision at the required distance is the one used. If the patient is young it is well to correct the refraction in both eyes. If mature, he may be given his choice between the proper correction for both eyes, or to

wear a pair of glasses like the one which suits his best eye.

SPECTACLES.—After all that has been said about the choice of glasses in the previous portions of this chapter, it is unnecessary to do more than to allude to the manner of mounting them. Although eye glasses are convenient for occasional temporary use, yet spectacle frames are adapted to the greatest number of cases. Gold, silver and steel frames have their respective advantages which naturally suggest themselves. The frames should fit the patient, both as to the height of the nose-bridge and as to the width between the temples. Each eye should look directly through the centre of its corresponding glass, and this requirement would bring the frames a little closer together for near than for distant vision. The glasses should be set ½ inch in front of the eyes in myopia and hypermetropia, but in presbyopia the situation is not of much importance. They should look a little downward for near, but straight forward for distant vision. As between pebbles and glass, the former have the preference for their superior hardness, which makes them less easily scratched, but the latter is homogeneous and better for refractive purposes. If spectacles are required to protect the eye from glare the tint called London smoke is the best, and the large, rounded *coquille* glasses are to be preferred.

CHAPTER VII.

DISORDERS OF THE OCULAR NERVES AND MUSCLES.

PARALYSIS OF THE OCULAR MUSCLES.—The normal action of these is as follows: The eye is turned inward by the internal rectus, outward by the external rectus, up by the superior rectus and inferior oblique, and down by the inferior rectus and superior oblique. It has also some motion of rotation on its axis. From the central line the emmetropic eye may move inward 45°, outward 50°, upward 35°, and downward 60°.

The *complete paralysis* of the *third cranial nerve* (page 18), causes the following state of affairs: The upper lid droops over the ball (*ptosis*), the eye is turned outward and cannot move in any direction, except incompletely downward; the pupil is dilated, the accommodation suspended, and, from lack of normal tension of the recti muscles, the globe is slightly protruded from the orbit. A partial paralysis is generally limited to one or more muscles, often causes giddiness or unsteady gait, and may present any portion of the above summary of symptoms. Limitation to a single muscle causes inability to move the eye beyond the middle line in the direction of that muscle. Mydriasis may occur from irritation of the sympathetic also; but in this case the accommodation is not affected.

Paralysis of the superior oblique causes homonymous

diplopia in the lower half of the visual field. The double images separate more widely as the eye is directed to the nasal side, and the upper ends of the images are inclined toward each other. The eye may be noticed to lag when the vision is directed downward.

Paralysis of the external rectus causes, according as it is complete or partial, more or less inability to turn the eye beyond the middle line. The limit of power is marked by an oscillatory movement of the globe, and may be measured by comparison with the other eye. The diplopia is homonymous.

In all cases of paralysis of single muscles the eye may generally be noticed to lag behind when an attempt is made to turn it in the direction proper to the action of such muscle. The test is usually made by holding a pencil in front of the patient, who is directed to keep the head steady and to follow the movement of the point with his eyes. The pencil is then shifted from side to side and in other directions in the same plane. If there is diplopia, the image belonging to the affected eye is always found in the direction opposite to that in which the cornea deviates from its proper motion. If the eye turns unduly inward the diplopia is homonymous. If it turns out, the images are crossed. If it deviates upward, its image is below; if downward, above. The eye to which an image belongs may always be found out by covering one eye with a card and ascertaining which image disappears. If the diplopia is but slight, or there is any uncertainty about its existence, it should be tested by means of a candle placed at twenty feet distance. If the patient is slightly amblyopic in one

eye the other should be covered with a red glass and the double vision will generally be well marked. Slight diplopia is more annoying than a great amount. After a muscle has been paralyzed for some time, the antagonizing muscle, in consequence of being always under tension, often becomes shortened. There is, in consequence, a constant abnormal convergence or divergence of the eye, and diplopia for nearly all parts of the visual field. This diplopia may be diagnosed from that of typical strabismus, by the fact that in the former the two images separate more widely when an attempt is made to use the paralyzed muscle. In strabismus they are the same distance apart everywhere in the visual field. In paralysis of the internal or external recti the face is turned toward the side of the muscle affected. In addition to this the paralyzed muscle may always be detected by observing that the diplopia is greatest on the side of that muscle, and least on the opposite side.

The affection is more often owing to syphilis than to any other cause, and the position of periosteal thickening or gummy tumor, in the course of a nerve, may sometimes be located in consequence of the exemption of certain branches from their effects. The condition of the nerve may, however, be a mere symptom of cerebral or spinal disease. When the abducens alone is affected the disorder is frequently rheumatic and is accompanied by pains in the temporal region. It is occasionally congenital. Tumors of the orbit often give the first indications of their presence by interfering with the action of one or more ocular muscles, but in this case the surgeon is not generally left long in doubt as to the real state of affairs.

The *prognosis* is usually favorable, and recovery sometimes takes place without treatment. In case the paralysis disappears the contraction of the antagonizing muscle relaxes at the same time. If the recovery is incomplete strabismus and diplopia usually remain.

The *treatment* must be addressed to the probable cause, and to find out this a minute inquiry into the history, and even the parentage, of the patient will often be necessary. An examination with the ophthalmoscope will frequently disclose an inflammatory condition of the optic nerve, depending upon intra- or extra-cranial specific lesion. In the great majority of cases we must rely upon the potassic iodide, mercury, or iodoform. If there is a history of rheumatism, with temporal pains, local bleeding is often of benefit. This may be followed by counter irritation, or vesication to the temple, and finally by electricity applied directly to the conjunctiva over the muscle. If diplopia is very annoying, the eye may be covered by a piece of ground glass set in one of the frames of a pair of spectacles. Although the double vision can be corrected by means of prisms, these are of no benefit for constant wear, on account of the variations in the amount of diplopia, according to the direction of the vision. An excellent plan is to exercise the paralyzed muscle frequently by trying to keep up binocular vision while turning the eyes beyond the middle line. Unless recovery has become apparently hopeless, it is best not to perform tenotomy on a contracted muscle, for if improvement should take place, the squint will prove to have been corrected too much.

After tenotomy has been performed, however (see *stra-*

bismus), its effect may be reinforced, if necessary, by shortening the tendon of the paralyzed muscle. The patient should be etherized, the lids separated by a stop speculum and a horizontal incision made in the conjunctiva, so as to expose the tendon. This is now to be raised on a strabismus hook (Fig. 41), and two curved needles, armed with fine silk, passed through the edges of the conjunctiva into the wound, and out through the tendon as far back as seems desirable. The tendon is now cut through between its insertion and the point where the sutures pass. The needles are then passed out through the stump of the tendon on each side, close to its insertion, and out through the edges of the conjunctiva. The threads being then tied, the ends of the tendon will be made to overlap. The sutures should be left in position until union takes place.

FIG. 41.—Strabismus Hook.

Wecker's operation, which is frequently performed, consists in passing the needles through the tendon of the muscle from without inward, after it has been raised on the hook, and then cutting the tendon off close to the ball. The needles are afterward to be passed under the conjunctiva and made to emerge, one above and the other below the cornea, in the line of its vertical meridian. If the ends of each thread be now tied tightly over the conjunctiva the eye will be brought into position. If these operations do not have sufficient effect, the tendon of the appropriate muscle in the other eye may be cut so as to endeavor to restore harmonious relations between the two.

PARALYSIS OF THE ORBICULARIS occurs usually in connection with the same condition of other muscles supplied by the seventh nerve. The lower lid falls away from the ball, and the eye cannot be completely closed. In consequence, the conjunctiva becomes inflamed and the cornea sometimes ulcerated. The treatment must be adapted to the condition of the nerve, and the subject belongs to the province of general medicine.

CONVERGENT STRABISMUS, or concomitant squint, is that condition of the eyes in which the optic axes meet before reaching the object looked at. It depends upon a shortening of the internal recti muscles, and generally commences in infancy. In most cases one eye only is used for vision and the other is turned in toward the nose; occasionally, however, we see a child who uses one eye for a short time, and then the other, or changes at will. The amount of squint is generally greatest during near vision, and often becomes almost imperceptible when the gaze is directed into the distance. At the commencement of strabismus the squint is usually not continuous, but alternates with periods of normal action of the muscles, and this state may continue for weeks, or even months before the interni become permanently shortened. If both eyes are used alternately the acuteness of vision in each remains good, but if one eye only is employed, the other becomes amblyopic from neglect, often to such a degree as to be almost useless. Such an eye appears perfectly healthy upon ophthalmoscopic examination, and its perceptive power may frequently be much improved by methodical practice upon such objects as it can see. If the eye remains amblyopic the interni some-

times finally relax, and the strabismus disappears, or is only occasionally perceptible. The amount of the squint may be measured by a rule, or more conveniently by a little ivory scale made to fit the curve of the under lid. The distance from the centre of the pupil to the punctum may be measured in both eyes, and the difference will be the amount of deviation.

To distinguish strabismus from paresis of the externus, it is necessary to cause the patient to cover and fix the eyes alternately on an object at some distance in the median plane. For the purpose of covering the eyes, a piece of ground glass placed near to the cornea is preferable, as the movements of the covered eye may in this way be seen. If both eyes deviate to the same degree the case is one of strabismus, but if they differ in this respect, the one which deviates least is the one to which the paralyzed muscle belongs. This phenomenon results from the greater effort of associated action made by the internus of the sound eye, in consequence of the increase of nervous force which is necessary to move the paretic externus. On the other hand, the amount of innervation required by the internus of the paralyzed eye, which is associated with the sound externus, being less, the inward excursion of the eye is less.

An exception to the universality of this rule of diagnosis is met with in cases where there is considerable difference in the degree of H in the two eyes. But the fact that H does exist makes the probability of strabismus greater than of paresis.

It is now well known that the ordinary cause of convergent strabismus is hypermetropia. This is explained

by the fact that there is a constant normal relation between the accommodation and the convergence. When the axes of the emmetropic eyes are parallel, the accommodation is relaxed for distant vision. When the accommodation is exerted for the perception of an object six inches away, the optic axes are converged to that distance. But in hypermetropia the accommodation is already exerted in order to see distant objects, and the eyes, therefore, have a tendency to converge, to the detriment of binocular vision. When the full strain is put upon the accommodation, in the desire to see a near object, the interni are impelled to converge the optic axes more than is necessary, and if the impulse to see distinctly is greater than the desire to retain binocular vision, one eye yields and squint results. The normal relation being restored between the accommodation and convergence the eye in use now accommodates more readily. There is no inducement to squint if the acuteness of vision cannot be improved by it, hence, we seldom find strabismus in the highest degrees of hypermetropia or when there is much amblyopia in both eyes, whether from defects in the refractive media, or from congenital inefficiency of the retina. For this reason, also, if the eyes differ in acuteness of vision or degree of H the worse eye is generally sacrificed for the benefit of the better one, and if an attempt is made to use the former the amount of strabismus is increased. As a small proportion only of hypermetropes with good acuteness of vision become strabismic, however, some other reason must exist for the exemption of the fortunate ones. And this cause is probably to be found in the difference of the relative power of the

externi and the interni in different individuals.* If the relative strength of the externi, as compared with the interni, is greater than in the average of emmetropic eyes, there will be no squint. If less, strabismus follows. Donders thinks that, owing to the difference between the optic and visual axes in the strabismic eye, the externi are overtaxed in trying to maintain distant vision, and hence give way during convergence.

Treatment.—If we can get the case at a sufficiently early stage, before the squint has become fixed, it can generally be cured by putting the correct eye completely under the effects of atropia, until the patient learns to use the other for fixation. When this happens, or if the eyes are used alternately, they must both be kept fully atropinized. As the use of the accommodation is now impossible, the child soon abandons the effort to see near objects distinctly, and the eyes act in unison. If the squint is fixed, however, and one eye has become amblyopic, the better one should be atropinized, and the other subjected to methodical daily exercise, in the hope of restoring its normal acuteness of vision. At the same time the refraction of both eyes should be tested; better by the ophthalmoscope only than not at all; and the full correction prescribed, if the child is not too young to wear spectacles. If the acuteness of vision can be restored to an equality with the other eye, the tendon of the internal rectus may be divided with some probability of regaining binocular vision.

The internus muscle is inserted into the sclera, at a distance of one-fourth of an inch from the edge of the

* *American Journal of Medical Sciences.* October, 1878, p. 418.

cornea, but is loosely connected also with the conjunctiva and with the capsule of Tenon. The patient being etherized, and the lids separated by a stop speculum, the conjunctiva should be seized, over the point of insertion of the muscle, with a fixation forceps. The eye should be rolled outward and the raised fold of conjunctiva snipped vertically, with a small pair of probe-pointed scissors curved on the flat. These must be introduced into the wound and the conjunctiva freed from its attachments to the sclera on either side of the muscle, and back toward the caruncle for about half an inch. The strabismus hook is then inserted at the lower angle of the wound and swept round, the point being kept close to the ball, so as to catch up all the fibres of the tendon. This is to be cut off between the hook and the ball, close to the sclera. A smaller hook should finally be used, to make certain that no fibres above or below remain unsevered. The conjunctival wound may be reunited at the very edges by a fine suture, or let alone if it does not gape. The patient must be cautioned not to use the eyes for near vision for a week, until the muscle has become again attached to the ball behind its original position, but no dressing is necessary.

The result of this operation is to relieve the abnormal convergence by about one-sixth, or one-fifth of an inch; but if the strabismus is double that amount, as is not infrequently the case, both eyes should be operated on. If the squinting eye is amblyopic, and vision cannot be improved, the operation may be limited to that eye, and its effect increased by a free division of the attachments between the muscle and the capsule of Tenon. For this purpose

the muscle is to be seized with the fixation forceps, after being taken up by the hook, and before being detached from its insertion. The hook should now be withdrawn, the tendon severed from the sclera, and the muscle turned back from the capsule, so that the membranous attachments between the two may be snipped with the scissors. The conjunctiva, also, should be freely loosened from its attachments, as far back as the caruncle, or even beneath it. This operation is performed for its cosmetic effects only, and if the eye should show a disposition to deviate in the opposite direction after the operation, a suture may be placed in the conjunctival wound, and made to include a sufficient amount of tissue to bring the cornea exactly to the middle line.

DIVERGENT STRABISMUS makes it appearance when the vision commences to be taxed by continuous near work, and it is usually a symptom of myopia. The rationale of its production is similar to that of convergent squint. The natural relation between accommodation and convergence comes again into action. In high degrees of M the accommodation is entirely suppressed, and convergence becomes forced and difficult, so that binocular vision of near objects is often sacrificed to avoid the discomfort arising from muscular asthenopia. In distant vision, such as it is, the strain is relieved, and the squint disappears. The oval form of the myopic eye makes all motion in its socket more difficult than for the round emmetropic eye. This is especially the case in convergence, on account of the strain to which the externi are subjected in consequence of their position. With these impediments to free convergence, it often hap-

pens that no attempt is made to attain it in high grades of M. Or, if one eye is emmetropic and the other myopic, the former is used for distant, the latter for near vision. There is no necessity for convergence, and there is none. But, the interni being totally relaxed to accord with the accommodation the externi, which continue in action, often cause divergence. This, from being occasional, becomes, after a while, continuous, and results in shortening of the externus. In bad cases the obliqui become shortened also. The same series of events occurs if one eye is blind, or highly amblyopic, and may happen if there is much difference in the degree of M in the two eyes.

Divergent strabismus may be distinguished from paresis of the internus by the difference in the amount of deviation in the two eyes, which occurs in the latter affection. The mode of testing the deviation is the same as described when treating of convergent strabismus (page 135).

Treatment must be based on the judicious selection of glasses, as already detailed under myopia (page 118). If the case can be seen at a sufficiently early stage, and a full correction of the M is admissible, it should be prescribed. Mostly, however, the deformity will be confirmed before the patient applies for relief, and then tenotomy of the externus is necessary. The operation is performed in the same manner as for the internus (page 138); allowance being made for the change of position, and for the fact that the point of insertion into the sclera is $\frac{5}{16}$ of an inch from the cornea. If the internus is still active a lessening of the deformity to the extent of $\frac{5}{16}$ of an inch may be obtained in this way. Both externi may be set back if this

is not sufficient. Or, the effect may be further increased by dividing the attachments to the capsule of Tenon. But in bad cases the latter expedient is not advisable, as the eye is more or less fixed in position by the permanent contraction of the obliqui. This, however, may be overcome to some extent by advancing the tendon of the internus by the operation previously described (page 133).

MUSCULAR ASTHENOPIA has already been alluded to as one of the annoying accompaniments of myopia. It occurs mostly in the lesser grades of the latter, as the strain on the interni in high degrees is relieved by divergent strabismus during near vision. If discomfort in using the eyes, inability to read, or sew, etc., leads to a suspicion of weakness of the internal recti, a screen may be interposed between one eye and the object of fixation, during near vision, and the eye observed, to see if it deviates outward. Or, a more delicate test, is that proposed by Von Graefe. A weak prism, refracting vertically, is placed before one eye, and the patient at reading distance directs his vision to a piece of paper, on which is drawn a vertical line with a black dot in the centre. If the relative strength of the muscles is preserved two dots will be seen on the line, but if the interni are weak, two lines appear, each with its dot. In cases of myopia with astigmatism, the symptoms of accommodative asthenopia are added to the strain of forced convergence, and headache, with other symptoms already detailed (page 108), often render the patient unfit for the ordinary avocations of life. The adaptation of proper glasses and the subsequent methodical exercise of the eyes, for increasing periods daily, always stopping short of actual fatigue, is usually all that is needed to complete a cure.

REFLEX ASTHENOPIA is characterized by feelings of discomfort in using the eyes; by inability to fix the vision on any object for more than a few moments, without causing pain, which lasts for some time; by a sensation of dazzling, or of tension, heat, and various ill defined feelings of annoyance in the organs of vision. Rest does not give entire relief from pain, and a return to necessary near work is always followed by a recurrence of the symptoms. Examination of the refraction may prove the patient to be perfectly emmetropic. The muscles of rotation and accommodation are normal. There is evidence, however, of a fullness of the ocular vessels. One or two enlarged veins may often be seen coursing over the white sclerotic. The retinal veins are seen, with the ophthalmoscope, to be dilated. This condition is very often associated with, and seems to depend upon, disorder of the genital organs. It occurs most frequently in young, unmarried, or if married, in childless women. In these cases there is usually uterine catarrh, menorrhagia and lack of nervous tone. In men, the prostate gland, or neck of the bladder, is generally in a condition of irritation, in consequence of excessive venery, or masturbation. The urethra is often abnormally sensitive. Success in treatment must depend upon ability to remove the cause, and it is unnecessary here to enter into any details with regard to these matters.

BLEPHAROSPASM is a reflex contraction of the orbicularis, coming on suddenly, without warning, and closing the eyes tightly for some seconds, or even minutes. It is of importance, on account of its liability to occur under circumstances where the use of the eyes is necessary to the

safety of the individual. The spasm may often be relaxed by pressure on the supra-orbital, or subcutaneous malar nerves. It is sometimes a mere symptom of hysteria. Other facial muscles may be involved. The affection is generally accompanied by congestion of the tarsal conjunctiva and undue sensitiveness to the action of light. If the cause can be determined, and it is occasionally owing to the condition of the teeth, the treatment is more satisfactory than under ordinary circumstances. If the spasm be relieved by pressure on the nerve, the skin over the nerve may be painted with iodine, or blistered, or the nerve subcutaneously divided. In the meantime the tarsal conjunctiva may be treated daily, or oftener, with weak astringent collyria. Constitutional measures must be addressed to the nervous system, and the liquor potassii arsenitis, in five drop doses, three times a day, is generally useful.

The blepharospasm which occurs in inflammation and injuries of the cornea is continuous. The orbicularis resists powerfully any attempt to open the lids, and the tonic spasm remains in some degree, even after the cornea is cured. In such cases, however, there is always to be found congestion, or inflammation of the tarsal conjunctiva. No special treatment is needed for the cure of this affection, which passes away with the complete recovery of the cornea and conjunctiva. Forcible stretching of the orbicularis by means of dilators and the operation of canthoplasty are often done for the immediate relief of this condition, but the ultimate cure is, probably, as speedy without them, and must, after all, depend upon a removal of the cause, viz.; the inflamed condition of the cornea and conjunctiva.

NYSTAGMUS is usually a congenital affection, or one which arises at a very early age, in consequence of the ocular muscles never having clear images on the retina to guide them in fixation. The eye, therefore, sets up a quick, oscillating movement, which becomes more marked the greater the effort to fix accurately. The motion is mostly from side to side, together with some degree of rotation. The interference with vision may be owing to corneal opacities, cataract, or disease of the retina, or choroid. As the patient has always been accustomed to this condition of the eyes, he is never conscious of an apparent motion in external objects, a phenomenon which becomes very annoying when the nystagmus is acquired later in life, as in the case of miners. These men, working in intense darkness, often in cramped positions, by the uncertain light of a single lamp, and with the eyes frequently directed upward for long periods, gradually lose control of the ocular muscles in some degree. Their nystagmus disappears in the bright light of day, to return with the shades of night. For congenital nystagmus there is no relief, but for the acquired form, absolute rest of the eyes, electricity, and tonics, especially strychnia, are recommended.

HERPES OPHTHALMICUS belongs properly to the affections of the nervous system of the eye, as it depends upon irritation of the Gasserian ganglion on the sensory root of the fifth nerve. The first indications of disease are given by severe neuralgia of the forehead, eyelids, nose, etc., limited to one side of the face. In a few days the skin becomes red and swollen, and groups of herpetic vesicles make their appearance. These presently form hard crusts,

which afterward fall off, leaving deep red scars, like those of smallpox. If the herpetic vesicles are on the nose the eye is pretty sure to be involved, if on the forehead, the vision may escape. The vesicles appear, if anywhere in the eye, on the cornea, leading to ulceration and often to rapid perforation, whereby the previously increased intra-ocular tension is reduced below the normal. Iritis complicates the disease, and the eye after being irritable for months recovers, with opacities of the cornea and impaired vision. The affection has been mistaken for erysipelas, but the severity of the pains which precede the eruption, the small amount of swelling, and the limitation of the disease to one side of the mesial line, serve to make the diagnosis. The eruption should be treated with lotions of lead water to the skin and atropia to the eye. To relieve the neuralgic pains, morphia sulphas, gr. $\frac{1}{8}$, and liq. potassii arsenitis, gtt. ij, may be given every hour.

NEURALGIA of the first division of the fifth nerve is nearly always accompanied by congestion of the ocular conjunctiva, lachrymation, increased intra-ocular tension and diminished acuteness of vision. These are the symptoms which often introduce an attack of glaucoma, a disease which will be considered in a future chapter. The pain may often be cured by morphia and arsenic, in the doses recommended in the last paragraph. If the attacks are periodic, a pill containing quiniæ sulphas gr. j, ferri et potassii tartras gr. j, morphiæ sulphas gr. $\frac{1}{24}$, taken every hour for ten doses, just before the expected paroxysm, will generally prevent it. It is best to precede the medicine by a cathartic. If there is a history of syphilis, potassium

iodide, in doses sufficient to produce the constitutional effects of the drug, should be administered. It must always be given with a large quantity of water, and is best tolerated when taken half an hour before a meal. If it produces unpleasant coryza, etc., iodoform in two to five-grain doses immediately after meals, may be substituted.

NEURO-PARALYTIC OPHTHALMIA occurs in consequence of paralysis of the fifth nerve. This usually results from intra-cranial lesions, which affect at the same time other nerves of the eye and face. The eye is devoid of sensation, the mucous membranes dry, the cornea becomes cloudy and ulcerates. The intra-ocular tension is below the normal. Inflammation of the cornea and conjunctiva may be prevented by keeping the lids closed so as to protect the eye from irritation. The disease is somewhat rare.

CHAPTER VIII.

DISEASES OF THE CORNEA AND SCLEROTIC.

PHLYCTENULAR KERATITIS is the most frequent form of inflammation of the cornea. Although not limited to childhood, it occurs generally in children. The essential feature of the disease is the occurrence on the cornea of papules, vesicles, or pustules, similar to those which characterize phlyctenular conjunctivitis. When these are situated at the margin of the cornea, they are usually very minute, several in number, and crowded close together like a string of beads. On the surface of the cornea they often occur singly and may be as large as a hemp seed. There is always a bundle of congested vessels on the sclera, running to the margin of the cornea nearest the phlyctenula, and the conjunctiva is hyperæmic, or sometimes even undergoes catarrhal inflammation. The phlyctenulæ finally break down with more or less loss of corneal substance. In light cases this is superficial, and soon heals, leaving a hazy spot in the epithelial layer. If the case is worse, the ulcer is deeper, slower in healing, and often leaves a depressed, cloudy cicatrix; or, the ulcer may become vascular and the cicatrix elevated. In some cases pus, or lymph cells invade the surrounding cornea, and accumulating in a rounded patch between the layers form the so-called *onyx*. In

rare cases the whole cornea becomes vascular and covered with superficial, minute ulcers, constituting a form of *pannus*. Even after recovery the disease is very apt to return, and phlyctenulæ often reappear upon the sites of old scars.

The child has an intense dread of light, and in many cases remains all day in the darkest corner of the room, lying prone, with its face buried in a pillow. It cannot open its eyes, and if the surgeon attempts to lift the lid he is met by spasmodic resistance from the orbicularis. This blepharospasm is supposed to depend upon pressure on the nerve filaments of the cornea by the lymph cells at and near the focus of inflammation. In most cases there is a papular eruption on the cheek around the lids, and even on the forehead, which at once gives a clue to the nature of the disease. To examine the eye, it is necessary for the nurse to lay the child on its back on her lap, at the same time holding its hands. The surgeon then takes its head between his knees and lifts the lid with the tip of his finger on the tarsal margin, or with an elevator. A gush of tears follows and the cornea is usually rolled up, out of sight, but in a few moments comes into view. The inhalation of a few drops of chloroform relaxes the blepharospasm completely.

The disease results from improper hygienic conditions, and is mostly confined to the poorer classes. Scrofulous children are especially liable to it, and in them it is difficult of cure, and apt to return again and again, until the sight is almost ruined by the resulting corneal opacities. Even if these are mere spots of faint haze which can be

seen by focal illumination only, they yet interfere much with vision.

Treatment.—The first indication is to relieve the extreme sensitiveness of the corneal nerves by the use of atropia and a drop of a four-grain solution should be placed in the eye every three hours until the pupil is dilated, the child being held as above directed. Care should be taken that the diet is simple and nutritious, devoid of the tea and coffee with which ignorant people often poison their children. Recovery from the stage of intense photophobia is accelerated by keeping the little patient in bed. At the same time remedies must be addressed to the general condition of the system. If there is constipation and plethora, a calomel purge should be given, followed by five to twenty grain doses of potassium acetate, in water, three times daily. If there is diarrhœa, it must be cured. If there is neither of these conditions, but the child is pale, or strumous, quiniæ sulphas, gr. ss, and syr. ferri iodidi, gtt. xx, should be given, in water, before meals. If none of these seem to be indicated Fowler's solution of arsenic may be administered in full doses. The constitutional measures must be persisted in until the cure is complete. Obstinate photophobia and blepharospasm, without much corneal disturbance, in children of full habit and with tumid upper lips, is often quickly relieved by the administration of full doses of iodoform, gr. vi–xij daily. If the photophobia is intractable, and kept up by an irritable, vascular ulcer, immediate relief will be obtained by an incision, about a quarter of an inch long, in that part of the corneo-scleral junction which is nearest the ulcer. thus opening the an-

terior chamber. The effect of this incision is both to relieve the intra-ocular tension and to sever the nerve fibres which go to the painful spot. The cut may be made with either a Graefe knife or a keratome, care being taken to avoid wounding the iris or lens, but especially the latter. The closed lids should afterward be covered by a dossil of absorbent cotton and a retaining bandage applied.

When the patient becomes able to open his eyes, and the extreme irritability has subsided, the ointment of the yellow oxide of mercury may be used, in the manner recommended under phlyctenular conjunctivitis, page 67. If this is too irritating recourse may be had to the collyrium of tannin. If there is a disposition to become chronic the corrosive sublimate solution, gr. ss ad f℥iij, may be used in the eye three times a day. If inflammation lurks in the tarsal conjunctiva a ten-grain solution of borax may be put in the eye five or six times a day. If pus forms between the layers of the cornea, hot belladonna fomentations (extract ℥j ad Oj,) should be applied to the eye, for ten minutes at a time, every two hours. Pannus requires no special treatment other than that which is applicable to the disease in general.

Interstitial Keratitis commences gradually with injection of the scleral vessels at the margin of the cornea, some lachrymation, photophobia, and pain. The centre of the cornea is usually the part first affected. It becomes cloudy, and by focal illumination it is seen that the substance of the cornea proper is the seat of the disease, which is, therefore, also called *parenchymatous* keratitis. The cloudiness spreads slowly toward the margin, where,

frequently, a rim of tolerably clear tissue is left. Sometimes, however, the disease commences near the margin of the cornea and spreads thence until the whole membrane is affected. When the clouding is complete the cornea looks like ground glass. After this condition has lasted for some time, grayish-yellow, slightly elevated spots make their appearance, as if pustules were about to form. If the case grows worse the cornea becomes vascular. Ulcers seldom or never occur. In recovering, the vascularization or cloudiness disappears first from the parts last affected, and finally some slight opacities only remain as traces of a disease which has lasted for months. In a few instances, the disorder commences in a number of spots throughout the substance of the cornea, forming a variety called *punctated keratitis*. These spots increase in size and number, finally run together and result in denser opacity and more irregularity of the corneal surface than in the ordinary form of the disease. Although the iris is liable to be involved in cases of interstitial keratitis, yet by the aid of focal illumination we may readily distinguish this disease from that kind of iritis which presents somewhat analogous symptoms, but in which deposits take place on the inner surface of the cornea.

The affection occurs mostly before puberty, in children who are the subjects of hereditary syphilis. Such a child has frequently a protuberant forehead, depressed nose, muddy complexion and coarse skin. The permanent incisors, especially in the upper jaw, as described by Mr. Hutchinson, are often, to some extent, peg-shaped, much smaller at the crown than at the base, with a depression in

the centre of the cutting edge. The temporary teeth are not affected. But the disease is not confined entirely to the syphilitic. It may be considered as evidence of some vice in the constitution, although occasionally persons who are otherwise apparently in good health become affected.

Treatment.—Atropia must be used to allay irritability, and for this purpose a drop of a four-grain solution in the eye, three times a-day, is usually sufficient. If the cornea is vascular, however, and there is considerable pain, the atropia must be used every two or three hours, and two or more ounces of blood taken by leeches behind the outer canthus. At the same time potassium iodide should be given in sufficient doses to affect the system. This failing, recourse may be had to iodoform in one to three grain doses, or if no improvement results in a week or two, mercurial ointment in quantities of one or two drachms should be rubbed into the skin of the sides of the chest or the inner surface of the thighs night and morning, or in infants, smeared on the soles of the feet or on a bandage round the abdomen, until some impression is made either on the gums or on the opacity of the cornea. If the gums are made slightly tumid it is well to keep up the impression for several weeks, by using smaller quantities of the mercurial. Syrup of the iodide of iron often hastens recovery, and is especially applicable to cases in which no syphilitic taint can be discovered.

VASCULAR KERATITIS, or acute pannus, may arise in the course of the various inflammatory affections of the cornea, or independently of them. There is always some

congestion or inflammation of the conjunctiva, during which minute vessels commence to encroach upon the cornea at its upper margin, covering that part which is generally hidden by the upper lid. The area of vascularity thus acquires a somewhat crescentic shape, and a similar patch forms afterward on the lower edge. The superficial layers only are affected. There is always a narrow, hazy belt of epithelium separating the vascular from the clear cornea. The areas of vascularity may extend until the cornea is completely encircled, and may at last cover its entire surface. Under proper treatment the disease can usually be stopped in any stage of its progress, and the vascularity will retreat first from the parts last affected, leaving behind patches of white opacity, which require a long time for their removal. Between this affection and the pannus of trachoma there is a difference of degree only. In the latter the vascularity is less dense, the vessels are larger and more or less clear cornea may be seen in the interstices of the network which they form. The disease probably often owes its existence to the application of irritants to an already inflamed cornea, or to transmitted inflammation from adjacent conjunctiva.

Treatment.—The local use of an anodyne, such as atropia sulphate, is always required, and a drop of a four-grain solution may be used thrice daily. Sometimes, even this seems to irritate, and then warm belladonna fomentations must be applied. The tarsal conjunctiva must receive appropriate treatment at the same time, but the astringents used should not be allowed to touch the cornea. The general health must be attended to, and proper hygienic

measures adopted. Patients affected with vascular keratitis are often in need of rest, both bodily and mental; or they may be suffering from malarial cachexia and require iron, quinine and arsenic; or strumous, or syphilitic, in which case the iodides of iron and potassium will be indicated.

SUPPURATIVE KERATITIS occurs generally in feeble constitutions, as a result of injury, cold, severe conjunctivitis, or other causes. The centre of the cornea is most liable to be affected, although the disease may begin at or near the margin. The first abnormal appearance is a spot of grayish infiltration, which soon becomes yellow. Any portion of the cornea anterior to the membrane of Descemet may be the seat of the disease, and if this is confined to the superficial layers an open ulcer is formed; if the inner layers are involved, there is an abscess. In any case the pus usually gravitates between the laminæ and collects near the lower margin, in a patch with a rounded upper edge, somewhat similar to the arcus at the base of a finger nail, and hence called *onyx*. The abscess may open either upon the outer or inner surface. In the latter case the pus accumulates at the bottom of the anterior chamber, forming a *hypopion*. This may be distinguished from onyx by the upper edge of the former being either a straight line or a curve with the concavity upward, and an examination by focal illumination will disclose at once whether the pus is in the cornea or in the anterior chamber. If the abscess spreads the corneal epithelium over it disintegrates, thus forming a superficial ulcer, which often creeps beyond the edges of the abscess. The iris, also, is usually involved (*Kerato iritis*), as may be seen by its insensibility to the

action of atropia, and it is possible that some of the pus in the anterior chamber may come from this membrane. The pericorneal conjunctiva is injected and swollen, and there is pain, lachrymation and photophobia. In slight cases, under proper treatment, the disease vanishes, leaving behind only a slight corneal opacity. But in severe ones, the hypopion increases, ulceration spreads, the iritis becomes worse, and perforation of the cornea may take place, followed at best by a permanent white cicatrix, perhaps with adhesion of the iris, or possibly by suppuration of the whole eyeball. A most destructive form of the disease occurs in variola, from the formation of a pock on the cornea.

Treatment.—In slight cases, nothing more than rest, the use of atropia, a pad of cotton and a *pressure bandage* are necessary as local applications. The eye should be covered with a small square of thin linen or muslin, and fine cotton placed upon this in such a manner as to fill up all the inequalities of the surface to a level with the brow. The end of the pressure bandage, which is a strip of fine flannel, $1\frac{1}{2}$ to 2 inches wide and $3\frac{1}{2}$ yards long, is then laid upon the forehead above the sound eye, and the roller is carried downward, obliquely across the cotton pad, under the ear of the same side, around the back of the head, above the opposite ear, straight across the forehead, around the head above the ears, obliquely across the eye again a little lower than the first turn, and so on until the eye is completely covered in with uniform pressure. If this bandage is properly applied, it will keep the eye at rest, and the patient will at once experience a sensation of considerable relief.

The state of the constitution must be improved by appropriate measures in most instances. Generally quinine and iron and a generous diet are required. Milk punch is often necessary in bad cases. If there is much pain a brisk cathartic will rapidly improve the condition of the cornea; or morphia may be administered, to procure sleep. Cold applications may be used locally in such cases, if agreeable to the patient. Most persons, however, have but little pain, and are best treated by hot fomentations. Water, as hot as it can be borne, applied to the closed lids, by means of bits of soft linen, for ten minutes at a time, every two hours, often answers admirably. The patient will generally be a better judge than the physician as to whether hot or cold applications are best for him. If the abscess shows no signs of absorption it should be opened at the lowest point, and the stringy pus pulled out with a pair of fine forceps. If near the margin of the cornea the incision should be made through into the anterior chamber. If a central perforation of the cornea is imminent iridectomy should be performed. A collyrium of muriate of quinia, grs. x ad f℥j, may be used every two hours, to diminish the amount of suppuration from the ulcerated surface. An eccentric perforation of the cornea may often be prevented by repeated paracentesis, but if perforation should take place, the compress and bandage must be applied continuously, to obtain speedy cicatrization.

Ulcerous Keratitis may include all forms of *ulcer of the cornea.* For clinical purposes these can be separated into two types, the sthenic and the asthenic. Ulcers belonging to the former class are accompanied by photo-

phobia, pain, ciliary injection and lachrymation; in those of the latter type there is more or less absence of these symptoms. A great majority of both kinds are of traumatic origin, made worse by neglect. Others are caused by the violence of inflammatory action in different kinds of conjunctivitis or keratitis already described. Others arise from deranged innervation or interference with the circulation.

Superficial ulcers of small extent are repaired by tissue, which is but slightly hazy (*macula corneæ*); the cicatrix can be detected, however, by focal illumination, and often interferes considerably with acuteness of vision. Sometimes the scar is marked by a depression or *facet*, at others by slight elevation and permanent vascularity. The deeper and wider the ulcer the more opaque the scar, and the nearer the centre of the cornea the more the sight is impaired. The incident most to be feared in the course of ulceration is perforation of the cornea, as in this event the iris and the lens are pushed forward against the membrane of Descemet and the anterior chamber obliterated. If the opening is very small it may shortly close again, and the parts be restored to their normal relations, with no trace left of the ulcer except a permanent white scar, *leucoma*. If cicatrization is delayed, however, more or less adhesion takes place between the iris and the margins of the perforation, forming an *anterior synechia*, which, after the scar is complete, makes an *adherent leucoma*. If the perforation is large, the iris adheres everywhere to the edges of the ulcer and projects through the opening, *prolapse of the iris*. In this position it becomes inflamed and may lead

to suppuration of the contents of the eyeball. Or the prolapse may become covered with new tissue, and cicatrization with flattening of the protruded membrane may take place. The scar, however, will always be weak, and, under the influence of accidental irritation, will probably yield to intraocular pressure sooner or later, and become thinned, and projecting, *anterior staphyloma*. The greater the area of destruction of the cornea, the greater the danger to the life of the eyeball, either through immediate suppuration or through the magnitude of the staphyloma.

In many cases of ulcer, although there is much irritation and vascularity of the cornea, the base and margin of the excavation are so transparent that it is liable to be overlooked. In others, a ragged ulcer appears on a gray or pus-colored opacity, with little pain and no vascularity, and the appearance of vessels gives the first sign of commencing repair. Sometimes a narrow sore forms near the margin of the cornea and spreads in a direction parallel thereto. This *ring-shaped ulcer* may usually be checked at any stage by proper treatment, but if allowed to run on until it encircles more than half the cornea, the latter becomes infiltrated, cloudy, and sloughs. If the floor of an ulcer becomes very thin it projects forward, in consequence of the intraocular pressure behind; and if the membrane of Descemet alone remains, it forms a transparent vesicle which may burst at any moment. This catastrophe not infrequently occurs during a forcible separation of the lids by the surgeon, for purposes of examination. In cases, therefore, where there is any possibility of such an accident, the lids should be opened with the greatest care, and for

the upper lid it is best to use an elevator. After such an ulcer has burst, its sides sometimes become lined with the remains of the membrane of Descemet, and a troublesome *corneal fistula* is formed, which will not heal until the membrane is removed. In rare cases the walls of one side of the ulcer are steep and transparent, and the other side is shelving and infiltrated. Such a sore creeps on over the cornea in the direction of the infiltration. It is the *ulcus serpens* of Saemisch, and generally arises without manifest cause. It has a tendency to terminate in perforation with consequent implications of the iris. The ulcers of neuro-paralytic ophthalmia generally involve the centre of the cornea, and begin with localized cloudiness.

Treatment.—Ulcers arising in the course of inflammatory affections of the conjunctiva or cornea, require, first of all, that the original affection shall be subdued by appropriate treatment. In every case attention to the condition of the system is imperatively demanded. If the ulcer is sthenic, rest in bed, cooling lotions, atropia sulphate ointment (gr. j ad cosmoline ʒj), in the eye, morphia, if necessary to relieve pain, and a free purge, together with the application of a cotton compress over the closed lids, and a pressure bandage sufficiently firm to keep the eye at rest, generally induces quick healing. If asthenic, hot fomentations must be used in place of cool lotions, eserine sulphate, gr. ss ad cosmoline ʒj, in place of atropia, and instead of purgation, liberal diet, tonics and stimulants, such as quinine, iron, beef tea, and milk punch. When healing commences local stimulation may be cautiously tried. A little calomel may be dusted in twice daily, with a camel's hair brush, or

the ointment of the yellow oxide of mercury may be used. An eight-grain solution of tannin is milder than either, and is especially valuable if the conjunctiva is affected. If these irritate, their use must be suspended and atropia, etc., employed again.

As healing progresses the *retaining* may be substituted for the pressure bandage. A convenient form is made of two thicknesses of muslin, one black and one white, cut diagonally from the material and 6½ in. long by 2¾ in. wide. It tapers at both ends, to receive the tapes; which may be black and each two feet long. Two of these are attached to one end of the bandage and one to the other. The bandage is to be applied diagonally across the cotton pad, the end with the double tape resting on the forehead. The tapes at the two ends (one having been previously carried below the ear), are crossed at the back of the head and tied in front. The third tape is carried below the ear of the sound side, round the back, and over the top of the head, and pinned where it crosses the others.

If the floor of an ulcer is evidently very thin, it is important to avoid a rupture, or to make it as small as possible. The former object can generally be attained by the performance of paracentesis, in the corneo-scleral junction, and the wound may be opened daily with a fine probe until the danger is past. Or a puncture with a fine needle may be made in the centre of the floor of the ulcer, care being taken to avoid wounding the iris or lens, and the aqueous humor allowed to drain off slowly. This must be repeated as often as may be necessary to relieve tension. The patient

must, of course, be kept in bed, and atropia and the pressure bandage applied. If such an ulcer is in the centre of the cornea or near enough thereto to seriously impair vision by its cicatrix, it is best to perform an iridectomy at once, and to keep the corneal wound from closing for a few days with the probe. If perforation and anterior synechia have already taken place when the case is first seen, the adhesion of the iris may sometimes be broken up by the diligent use of atropia; and rest and the pressure bandage must be used until the ruptured cornea heals. For the cure of the creeping ulcer, Saemisch recommends an incision with a narrow knife (Graefe's), through the cornea and directly across the centre of the ulcer. The knife is entered with its back to the iris, in the sound tissue on the temporal side of the ulcer, until the point is in the anterior chamber. The point is then carried across, through the aqueous humor, and made to emerge in the sound corneal tissue on the nasal side of the ulcer. The knife is finally made to cut its way out slowly, to avoid a sudden burst of aqueous. The sensibility is, in general, not acute, and the operation may be done without ether. The wound should be opened daily, and a Weber's knife serves well for this purpose. This operation certainly puts an end to the extension of the ulcerative process, and answers admirably if the ulcer is above or below the pupil. But when it is in the centre of the cornea an iridectomy is to be preferred, for this at the same time cures the disease and gives a new pupil opposite clear corneal tissue. In cases of perforation where there is prolapse of the iris, which is still bulging at the end of ten days or two weeks, a wedge-shaped

piece may be snipped out of the most prominent part with a pair of scissors, in order to facilitate flattening of the cicatrix. Corneal ulcers which follow herpes frontalis are generally hastened in their recovery by the administration of mercury in addition to the treatment required for ulcers in general. A corneal fistula may usually be closed by touching it with a point of lunar caustic. This failing, the surface of the fistula may be abraded with a cataract needle. Or, finally, it may be necessary to have recourse to an iridectomy. In any case a pressure bandage will be required.

CORNEAL OPACITIES interfere with vision in proportion to their size, density and nearness to the axis of the eye. If much smaller than the pupil, however, a dense opacity causes less impairment of the sight than one which is somewhat translucent, for the latter allows the passage of rays which only lessen the definition of the retinal image. If the entire cornea is opaque the condition is known as *total leucoma*. If some clear cornea is left, and the pupil is active, there is always some sight in the corresponding portion of the visual field. Cicatrices interfere with vision, not only by their opacity, however, but by the distortion which their contraction produces in the refracting surface of the cornea. The result is usually irregular astigmatism. Very dense opacities, even after perforation, occurring in childhood, or youth, may almost entirely disappear in the course of time. In this way a central capsular cataract may be left with scarcely a distinguishable mark on the cornea. In maturity, as long as the inflammation lasts which gave rise to the opacity, the latter may continue to

improve, but no improvement will take place after the inflammation is gone.

In consequence, stimulating applications may be used in treatment for a considerable time. Calomel is the best to begin with. Afterward the ointments of the yellow or red oxide of mercury; or collyria of sulphate of sodium (saturated solution), potassium iodide, ʒj ad fʒj, wine of opium, fʒss ad fʒj, or any of the ordinary astringents may be tried, one after the other. Very often none of them seem to be of much benefit. In this case recourse may be had to operative measures. Deposits of carbonate of lead, which sometimes occur from the use of acetate of lead collyria while the cornea is abraded, may be scraped or scaled off. If the pupil is hidden by an opacity, a new pupil may be made elsewhere. Operations, however, should not be attempted until the eye has entirely recovered, and no longer becomes red and irritable under examination.

Other things being equal, the best position for an artificial pupil is on the nasal side of the cornea, at or below the middle line, and the next best is at a corresponding point on the temporal side. Many things, however, conspire to interfere with our choice of these locations, and practically, a spot must be selected which is uncovered by the lids, is nearly on a level with the pupil of the other eye, and is behind the best part of the cornea. To determine the last condition, the pupil should be widely dilated with atropine, and the cornea carefully examined by focal illumination, to detect opacities, and by the direct method, with the ophthalmoscope, to discover irregular astigmatism. If this defect exists, the small retinal vessels will look

wavy and blurred, and cannot be cleared up by any lens. There will be a difference in the refraction at different parts of the cornea, and the details of the ocular fundus will change shape as the observer moves about over the pupil. The irregularities of the corneal surface will also be made evident by using the mirror at 8 or 10 inches, with a positive lens of appropriate focal distance.

This condition may be largely relieved by the use of Donder's stenopaic apparatus, which is a metal plate, large enough to cover the eye, pierced with a small hole, or slit. Behind such a screen the pupil dilates, and the patient may place the hole opposite that point of the cornea which is most favorable for accurate vision. Any desired lens may be used at the same time. This arrangement often gives excellent definition, and answers well for reading or sewing, but is useless for walking, on account of the accompanying contraction of the visual field.

If an operation is decided upon, the object will usually be to make the new pupil as small as possible. The general result of an ordinary *iridectomy* is a pupil which is opposite the margin of the lens, and is too large for accurate vision. The iridectomy for artificial pupil is best performed by using a narrow keratome (Fig. 42), which should be entered in the corneo-scleral junction, with the blade parallel to the plane of the iris. The point must be managed so that it does not come in contact with the lens, either while the knife is pushed forward, or as it is rapidly withdrawn. If the iris

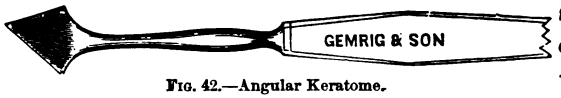

FIG. 42.—Angular Keratome.

now presents at the wound, it is seized with a pair of fine iris forceps, the free edge gently drawn out and cut off. If it does not present, Tyrrell's hook (Fig. 43) should be introduced flatwise into the wound, and passed over the free edge of the iris, which is then drawn out and cut off. Any iris remaining in the wound should be replaced by means of Wecker's tortoise shell spatula, and by rubbing the wound gently with the closed lids. The operation can be done most accurately under ether; the lids should be controlled by a stop speculum, and the ball held by an assistant with fixation forceps. A cotton compress and pressure bandage over the closed lids, to keep the eye quiet, is all the dressing required.

FIG. 43.—Tyrrell's Blunt Iris Hook.

If a narrow rim only of clear cornea is left the operation of *iridodialysis* may be performed, for the incision of iridectomy always leaves a hazy or opaque spot at the margin. To avoid this, the incision may be made in the already opaque portion of the cornea, a pair of fine forceps introduced and the iris gently torn from its attachments at the point selected. Any portion of iris drawn through the wound in the cornea should be snipped off close to the surface.

Wecker's operation of *iridotomy* is most appropriate for cases where the lens is absent, and will be described in a future chapter.

Critchett's operation of *iriddesis* is performed by opening the cornea in front of the corneo-scleral ring, drawing out the iris with a hook, and tying a fine silk thread round the hernia. The constricted portion separates in a few days.

By this means the pupil may be dragged opposite a portion of clear cornea, but the eye is left with adherent leucoma, and is liable to irritation, or even inflammation, from this source.

Anterior synechiæ, indeed, if large, are often dangerous to the integrity of the eye, and when there is adherent leucoma, with constant irritability, it is best to operate and cut the synechia loose. A keratome may be entered between the leucoma and the corneal margin, and the point made to penetrate the centre of the adhesion, which will be divided on each side as the blade is pushed onward.

Finally, an opacity of the cornea, which is white and conspicuous, may be tattooed with India ink by means of a little bundle of fine needles, and thus rendered almost unnoticeable. Several sittings may be required, sufficient time being allowed between for the irritation to subside. The lids should be separated with a stop speculum, and a small piece of absorbent cotton placed at the outer part of the free edge of the upper lid, to prevent the tears from washing the ink away.

Arcus senilis is an opacity which makes its appearance about the age of fifty. It is confined to the margin of the cornea, is due to fatty degeneration, occurs first at the upper, afterwards at the lower edge, and finally encircles the membrane.

Anterior or Corneal Staphyloma results, as has already been described (page 158), from a perforating ulcer of the cornea. Even a small ulcer, if situated in the centre of the cornea, may involve the entire free edge of the iris in its cicatrix, and thus prevent communication between

the anterior and posterior chambers. This always leads to an increase of the intraocular pressure, and hence to distention of the cicatricial tissue, which is generally weak, from the remains of inflammatory action. A staphyloma, once formed in any part of the cornea, is liable to renewed attacks of inflammation, in each of which the new tissue softens and yields to the pressure of the aqueous humor, and thus continually grows larger. If at last the lids fail to cover entirely the projection, inflammation becomes chronic and the intraocular contents are finally disorganized.

Treatment.—Much may be done in the way of prevention by an immediate excision of protruding iris in cases of perforating ulcers of the cornea. If the ulcer is considerably less than half the size of the cornea, a firm cicatrix may in this way be obtained. A partial staphyloma which leaves sufficient sound cornea to admit of an artificial pupil may generally be prevented from extending, and even be diminished in size, by the performance of an iridectomy. The operation should be done as early as possible. In the case of an infant, delay in prompt action will be very apt to result in the production of permanent *nystagmus* also. If iridectomy does not relieve the staphyloma an elliptical piece may be cut from its summit by transfixing it with a Graefe knife (Fig. 44), which in cutting its way out will make one side of the incision. The other side may be completed with the scissors. The wound must be a diminutive copy, both in shape and direction, of the palpebral interspace in the open eye. If

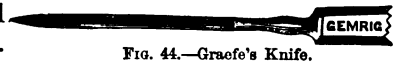

FIG. 44.—Graefe's Knife.

the lens is found to be luxated it should be removed. A good-sized cotton compress and a well applied bandage will be sufficient to bring the edges of the wound in apposition.

TOTAL STAPHYLOMA, in addition to the inconvenience to which it gives rise by inflammatory irritation, may eventually involve the other eye in sympathetic ophthalmia. All this can be prevented by an early abscission of the staphyloma or by enucleation of the eye. *Abscission* is performed by cutting out an elliptical piece, similar in shape to the palpebral interspace, the incision being confined to the sclerotic, behind the ciliary region. The conjunctiva may then be drawn together in a horizontal line by four or five sutures, and a pad and bandage applied. The stitches usually ulcerate out in two or three days, however, the scleral wound gapes, and one or two months elapse before the stump is ready for an artificial eye. In addition to this, if the intraocular tissues are not sound at the time of the abscission, the operation is apt to be followed by bleeding from the choroid, inflammation and suppuration of the interior of the eye, and final shrinking of the stump to a useless and irritable button.

These results may be avoided and time saved by the operation of *enucleation*. The patient being etherized, and the lids separated by a speculum, the conjunctiva may be divided, with scissors, in a circle around, and about one-eighth of an inch distant from, the cornea. The muscles are then caught up, one after another, by a strabismus hook, and cut from their points of insertion. The ball is

to be seized with fixation forceps, and a pair of scissors well curved on the flat are inserted beneath the conjunctiva on the temporal side, and passed around the globe until the point comes in contact with the optic nerve, which is then divided. The globe is now removed without difficulty, any adherent shreds of cellular tissue being snipped asunder as the eye emerges from its socket. The bleeding is generally trifling, and requires no special attention; but the cavity may be plugged with sponge and a pressure bandage applied for three or four hours, to prevent subcutaneous infiltration and discoloration, if desired. The stump usually heals sufficiently to allow the insertion of an artificial eye in a week, or even less. If fungous granulations make their appearance from within the ring of contracted conjunctiva, they should be snipped off with scissors. The artificial eye should be inserted as soon as possible, so as to prevent contraction of the lids and conjunctival sac, and should be replaced by a new one as soon as it wears rough or is in the least degree irritating.

SCLERAL STAPHYLOMA may arise by extension of the atrophic process from the cornea, or as a result of choroiditis, scleritis, or intraocular tumors. The thinned part becomes prominent and bluish, and the internal coats of the eye are usually distended and atrophied. When all the anterior parts of the eye are involved, the disease is sometimes called *buphthalmus;* if the entire organ is affected, it is called *hydrophthalmus*. The vision is usually lost from implication of the nervous structures, and enucleation and adaptation of an artificial eye is generally advisable. In hydrophthalmus a better stump may sometimes be obtained

by passing a seton through the eye, to excite suppurative choroiditis.

INJURIES OF THE CORNEA AND SCLEROTIC occur from the contact of all sorts of objects. Particles of dust, coal ashes, cinders, etc., sometimes adhere to the corneal surface and set up irritation which may run on to inflammation and the formation of ulcers. Oftener, minute chips of metal, stone, or glass, the results of mechanical processes, grains of powder from explosions, and other small particles, strike the cornea with sufficient force to imbed themselves in its substance. Such *foreign bodies* are often difficult of detection if they lie in front of the pupil, or if the patient has a very dark iris, but they may always be seen by focal illumination, especially with the aid of a lens. They generally set up great irritation, photophobia, lachrymation, etc., which, in some states of the system, may run into ulcerous keratitis. In any event, the wound left after their removal requires more or less time for the completion of the reparative process.

If the patient is of steady nerve, he may be seated facing the window, and the surgeon, sitting in front of him, may control the eyelids with one hand, while with the other the foreign body is removed by means of a pick (Fig. 45), the

FIG. 45.—Eye Pick for Removing Foreign Bodies.

patient meanwhile keeping the vision fixed on some object in a convenient position. If the patient is not able to con-

trol the movement of his eyes, the surgeon may stand behind him. The patient should lean his head against the breast of the surgeon, who may then, with the tips of the first and second fingers of his left hand, press firmly on the ball and steady it in the desired position. Still more refractory patients should be placed in the recumbent position, the lids separated by a stop speculum and the ball held firmly by fixation forceps. For children, an anæsthetic will mostly be necessary. Particles of iron generally leave behind them a stain, which must not be mistaken for the foreign body, and which usually disappears in a day or two. In the great majority of cases the only after treatment required is the occasional application of cold water, or of a four-grain solution of borax. If the irritation continues, however, a small piece of the atropine ointment, gr. j ad cosmoline ʒj, may be put in the eye, three or four times a day, and a pressure bandage applied.

Sometimes a splinter of wood or metal may penetrate the cornea, and project into the anterior chamber, while the outer end is perhaps below the level of the outer surface. Such an accident places the lens in imminent danger. A small opening should be made at a convenient part of the corneo-scleral junction, and Wecker's tortoise-shell spatula introduced beneath the point of the splinter to push it out, if practicable, or otherwise to steady it until it can be removed by the pick.

Chemical corrosives and blows from large objects sometimes abrade the surface of the cornea, and much irritation follows, which may be subdued by atropine ointment, cold water, borax lotion and a pressure bandage. Burns from

molten metal or from chemicals are frequently of a deeper and more dangerous character, however. In the worst cases the life of the cornea is destroyed, and no treatment is of any avail. Lesser injuries, if they do not give rise to panophthalmitis, are followed by dense opacities and often by symblepharon.

Punctured wounds of the cornea are often made by forks, scissors, steel pens, etc. Incised and lacerated wounds result from a variety of causes. The iris and lens are frequently injured at the same time. The former generally prolapses, and if seen within a few hours before adhesions have formed, the hernia may be returned by pressing out of it any aqueous humor which it may contain, and then rubbing it gently with the upper lid. If restoration cannot be accomplished, the prolapse should be cut off close to the corneal surface, with scissors. If prolapse has not occurred, but is threatening, and the wound is near the pupil, atropia should be used, but if the wound is eccentric a small piece of the ointment of sulphate of eserine, gr. ss ad cosmoline ℥j, must be put in the eye thrice daily. The cornea will even tolerate a fine silk suture, if necessary.

Foreign bodies of various kinds frequently pass through the cornea into the eye. If such an object lodge in the angle of the anterior chamber it may usually be removed through an incision made at the spot, with a keratome. If the object adheres to the iris, that portion of the membrane must be drawn out of the wound and snipped off. If it enter the lens, the latter will become cataractous and should be removed. If it pass beyond, into the interior

of the eye, and cannot be removed, the organ should be enucleated.

Penetrating wounds at the corneo-scleral junction, involving the ciliary body, are especially dangerous, on account of the subsequent tendency to the occurrence of sympathetic ophthalmia in the other eye.

Wounds of the sclerotic, posterior to the corneal margin, are often accompanied by escape of the vitreous humor. A fine suture should be introduced for a day or two, if necessary, to keep the edges of the wound together, and cold applications or a pressure bandage applied. A rupture of the ball is sometimes accompanied by an extrusion of the crystalline lens, which often remains beneath the conjunctiva. If the rupture is in the ciliary region time will be saved and safety insured by an immediate enucleation of the organ. But if the wound is further back, the sclerotic should be allowed to heal completely before the lens is removed.

CONICAL CORNEA, or *kerato conus*, is a condition in which the cornea, instead of being a portion of a sphere, becomes somewhat pointed. The centre, in bad cases, is occupied by a clear protuberance almost like a tear drop. The affection arises gradually, and is not due to increase of intraocular pressure, but to diminished powers of resistance in the corneal structure. There is an atrophy of the corneal elements, which at the centre of the membrane often dwindle to one-third of their original thickness. As the disease progresses, the apex of the cone is no longer properly protected by the lids, and becomes rough and finally opaque. The conus commences usually in individu-

als between fifteen and thirty years of age. Both eyes are affected generally, but in different degrees, and the progress of the malady is hastened by the strain of continuous near vision. It may cease to increase at any stage, and never goes so far as to rupture the cornea, for as the membrane becomes thinner its capacity for exosmose increases, until the diminished intra-ocular tension balances the lessened powers of resistance. As the axis of the eye is so much lengthened it becomes affected with myopia of a high degree, which cannot be corrected by means of spherical glasses, because the refracting surface at the top of the cone is different in curve from that of the sides. On account of the great enlargement of the retinal image, however, the patient can generally read at a very short distance. In every case of progressive myopia the cornea should be examined, to ascertain whether its condition will not account for the change in the refraction, and slight cases of conical cornea must not be mistaken for myopia with amblyopia.

The diagnosis is easy if the conus has progressed considerably, for the pointed shape of the cornea is then well marked, when viewed in profile. In slight degrees the ophthalmoscope will disclose irregular myopic astigmatism, and if the mirror is held at ten or twelve inches from the patient's eye his cornea will appear bright in the centre and at the margin, with a dark zone between. If the light be cast a little obliquely, the half of the cornea opposite the light will be in shadow, and this shadow will play around the cornea as the mirror is moved.

Much may be done for the relief of moderate degrees of

distention, by a careful study of the refraction and a combination of cylindrical and spherical lenses, and these may often be improved by covering them, so as to leave but a small, central stenopaic hole or slit. Bad cases, however, require the performance of Von Graefe's operation, which consists in shaving off the very tip of the conus and allowing the wound to heal. The subsequent contraction of the scar flattens the cornea. The operation may be done with a keratome, the point being pushed through the centre of the tip, the blade cuts its way out on both sides as it goes. If the flap remain adherent on one side, it may be separated with scissors. The smallest possible opening should be made into the anterior chamber. The pupil should be widely dilated with atropine before the operation. After it is over a compress and bandage must be applied and inflammation moderated by appropriate measures. After healing has taken place, an artificial pupil should be made by iridectomy, in the most desirable place, and the central scar tattooed.

KERATOGLOBUS.—As a result of severe pannus, or vascular keratitis, the corneal powers of resistance are sometimes so much diminished that the entire membrane becomes distended. The adjoining portion of the sclerotic also often suffers, is thin and blue, the iris is stretched and inactive (*buphthalmus*). A large iridectomy, the iris being taken away close to its attachment, is a possible remedy, if there is also central opacity.

In old persons the cornea often atrophies throughout and becomes thin and flaccid, so that it collapses at once if the anterior chamber is opened.

TUMORS OF THE CORNEA AND SCLEROTIC are of infrequent occurrence. Carcinoma may, of course, appear anywhere. *Dermoid* tumors are sometimes found on the edge of the cornea, encroaching on its substance as well as on that of the sclera. They are usually congenital, seldom larger than a pea, of a smooth or warty surface, white or brownish in color, often producing hairs and composed of the elements of the integument. They may readily be removed by the knife. *Melanomata* sometimes grow from the corneal border. They are of warty appearance and deeply pigmented. *Sarcomata* arise in the same position. Both of the latter may overlie the adjacent structures and grow sufficiently to interfere with the closure of the lids. Their removal should be especially thorough at the point of origin.

SCLERITIS occurs to some extent in every severe case of iritis, keratitis, conjunctivitis, or choroiditis, and its symptomatology and treatment is included in the accounts of those affections. Sometimes, however, the disease arises independently and is localized in one or more patches in front of or at the equator of the eye. This *episcleritis* attacks the tissue immediately beneath the conjunctiva, seems to be somewhat herpetic in character, is accompanied by pain, tenderness, localized swelling and congestion, lachrymation and proliferation of the connective tissue corpuscles. The severity of the affection depends on the spread of the inflammation to the deeper parts of the sclera and choroid, or to the cornea and iris. In the latter case more or less corneal opacity and adhesions of the iris to the lens take place. Slight cases last a month or more. In those

of greater severity the connective tissue corpuscles undergo a certain amount of fatty degeneration, which causes a weak spot to be left in the sclera, and generally results in the formation of a staphyloma. Like phlyctenular conjunctivitis, the disease tends to recur, and not infrequently terminates in destruction of the usefulness of the eye through the formation of scleral staphyloma and corneal opacity. In the acute stage the pain is to be moderated by the use of atropia, warm fomentations, and, if necessary, leeches to the temple. Afterward, rest, a pressure bandage and the ointment of the yellow oxide of mercury may be used to facilitate recovery. Constitutional measures must be adapted to circumstances.

CHAPTER IX.

DISEASES OF THE IRIS, CHOROID AND CILIARY BODY.

PLASTIC IRITIS often commences in an insidious manner. The patient feels that the eye is weak and that he cannot look at near objects continuously. But the affection is not usually presented to the notice of the physician until it has already lasted several days. It is then characterized by congestion of the sclerotic vessels immediately around the cornea, by change of color of the iris, lessened mobility of the pupil, lachrymation, impaired vision, often by considerable pain, and generally by more or less turbidity of the cornea. On account of the importance of the subject these symptoms must be considered somewhat in detail.

The pericorneal congestion is known to be in the sclerotic, by the fact that the vessels all radiate from the cornea and that the conjunctiva may be moved about over them. The conjunctival vessels are liable to become hyperæmic, however, in the course of the disease, and to conceal those of the sclerotic to some extent.

Owing to the increased amount of blood corpuscles in the vessels of the iris, the latter, if blue, becomes greenish, if dark, reddish. The surface of the membrane loses its brightness also, being obscured by the somewhat turbid cornea, or aqueous humor.

The sluggish action of the pupil may be tested by cover-

ing the other eye with the hand, when the pupil of the diseased eye will be found not to dilate quickly, as is the case in health. Or, both eyes may be covered for a few moments, and then suddenly opened. The pupil will be found to have dilated but little in comparison with that of the sound eye, and will contract but slowly under the stimulus of light. Or, the pupil may be apparently quite immovable. If any doubt remains as to the nature of the malady a drop of a four-grain solution of atropia should be put between the lower lid and the ball. In a healthy iris this would widely dilate the pupil within half an hour, but in iritis there is either no action or the pupil is irregularly dilated, perhaps as represented in Figure 46. If the eye be now examined by focal illumination the irregularity of the pupil will be found to be owing to fibrinous adhesions having taken place, at one or more points, between the free margin of the iris and the capsule of the lens, with which it is naturally in contact. These *posterior synechiæ* may possibly be the remains of a previous iritis and inquiries should therefore be made as to a former attack.

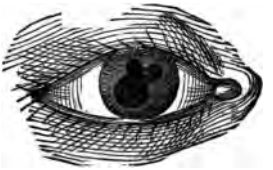

FIG. 46.—Posterior Synechiæ.

The pain of iritis is somewhat variable and neuralgic in character. It is usually worse at night, prevents the patient from sleeping, and is confined to the sensory branches of the fifth nerve, but especially to the temple and supraorbital region. Intolerance of light is also a variable symptom which seems to be greatest in cases of a rheumatic origin.

In extremely severe cases of iritis there is sometimes hypopion.

It is most important to distinguish this disease from conjunctivitis, as the astringents which are beneficial to the latter aggravate intensely the inflamed iris, increase the number and extent of the posterior synechiæ, and, if continued, lead inevitably to destruction of vision. The mistake is readily made by inexperienced or careless observers, and many an eye has been irretrievably ruined in consequence. Careful attention to the foregoing ensemble of symptoms, however, and the use of atropia in doubtful cases, will insure safety. It is well to bear in mind at the same time, that in iritis the discharge consists of tears only, but in conjunctivitis there is also mucus or pus, or both. Mere corneal affections sometimes resemble iritis, but the instillation of atropia is usually sufficient to dispel all doubts.

The origin of iritis is often attributable to cold, to rheumatism, to variola, to syphilis, or to extension of inflammation from adjacent tissues, but frequently also the cause cannot be ascertained. Under proper treatment the malady should be completely cured in a month, or perhaps a little longer.

The same cause, however, which produced the first attack will tend to produce others, hence we have *recurrent iritis.* The existence of posterior synechia has been thought to be the cause of these relapses, but many persons go through life with one or more adhesions of the iris to the lens capsule, without having a second attack of iritis, and the malady not infrequently recurs in cases where the pupillary

margin is quite free. With every attack, however, if not efficiently treated, the iris becomes adherent in new places, or old adhesions extend, until at last the entire pupillary border is fastened down, and the pupil itself is often contracted and filled with plastic fibrin.

This condition of *complete synechia* is, if unrelieved, destructive to vision. The aqueous humor, which naturally finds its way out of the eye through the pupil to the iridocorneal angle, being pent up behind the iris, pushes the latter forward, diminishes the depth of the anterior chamber, and increases the intraocular pressure, the choroid becomes inflamed, and degenerative changes in the tissues of the globe follow, which show their effects first in contraction of the visual field, and finally in blindness. In some cases the entire posterior surface of the iris becomes adherent to the lens capsule. This condition is recognized by the flatness of the membrane, notwithstanding the closure of the pupil and interruption to the flow of the aqueous humor. The lens and vitreous are soon affected and lose their translucency.

Any inflammation of the iris arising after syphilitic infection is called *syphilitic iritis*. It is by no means sure that even a majority of these cases is due to the specific poison. They are mostly of the ordinary plastic form, but occasional instances are characterized by the occurrence of gummata on the surface of the iris. These are generally reddish in color, being well fed with blood vessels, but are sometimes of a yellowish tinge. There is also considerable scleral congestion in the vicinity, but no great amount of pain. The gummy tumor often grows rapidly, until checked

by treatment, when it is as rapidly absorbed and disappears without leaving a trace. If not promptly treated it may go on, however, to destruction of the eye.

Owing to the fact that the iris, ciliary body and choroid are so intimately connected with one another, iritis, if it becomes chronic, is pretty sure to involve the other tissues. The *irido-cyclitis* and *irido-choroiditis*, which arise under such circumstances, cannot readily be separated in practice. The ciliary region becomes tender to the touch. The episcleral congestion is greatly increased, and the visual acuteness undergoes a marked diminution in consequence, not only of turbidity of the vitreous, but of separation of the retina from choroidal effusion. The eyeball, which was before abnormally tense, now becomes as much too soft, and finally dwindles to a sightless nodule (*Phthisis bulbi*).

Treatment.—All use of the eyes for near work must be forbidden in iritis. The patient will recover most quickly if not allowed to go out in cold or damp weather, but if kept warm in a somewhat darkened room. If it be necessary to go out at such a time, however, the eye should be protected by means of a cotton pad and a retaining bandage. In warm weather a pair of London-smoke coquille spectacles will be sufficient. But, in any case, the first thing to be done is to get the eye fully under the influence of atropia. A drop of a four-grain solution may be placed inside the lower lid every half hour, until such portions of the iris as are not bound down by synechiæ are fully dilated. Afterward a drop three times a day will suffice to keep up the impression. If the pupil dilates freely, the above is all the treatment that will be required, but the

influence of the atropia must be maintained until all traces of congestion have entirely disappeared. If the patient is apparently quite well, and the atropia suspended, its use should be at once recommenced whenever undue vascularity shows itself.

If there are posterior synechiæ of very recent formation, atropia alone will often break them loose; but if they resist its action for three or four days, mercury should be administered. A half grain of calomel, with one-eighth of a grain of opium, three times a day, should be continued until a slight swelling of the edge of the gums is produced, and the dose should then be diminished so as, at the same time, to maintain and to prevent any increase of the degree of mercurial impression. If disorder of the stomach or bowels interfere, a drachm or more of the mercurial ointment may be rubbed into the sides of the chest night and morning, and as soon as an impression is made, the amount used may be graduated so as to keep up the effect. Unless synechiæ are old they generally give way under this treatment; but if still firm at the end of a month, it is useless to continue the mercury longer. The question of syphilis does not enter into consideration in commencing this treatment, although, of course, if a gummy tumor make its appearance upon the iris, the action of the mercurial must not be delayed. An attack of iritis, however, will not infrequently commence in a patient who is already under the influence of mercury for the relief of syphilis.

Pain, if it prevents sleep, interferes with recovery, and may usually be fully relieved by taking an ounce or two

of blood from the temple by leeching, or by the apparatus of Heurteloup. Afterward, the patient should remain in a darkened room for twenty-four hours, to prevent reaction. If the pain should be persistent, and there is increase of intraocular pressure, which may be judged by the hardness of the ball, as felt through the closed lids with the tips of the fingers, paracentesis of the anterior chamber should be performed. If there is much vascular excitement, a purge may be administered; and if the pain is neuralgic in character, recourse must be had to morphia, hypodermically or otherwise.

If posterior synechiæ remain, after the congestion has disappeared, they need cause no uneasiness, except as they contribute just so much toward complete pupillary adhesion in case of relapse, of which, after every attack of iritis, there is always danger. Hence, although nothing need be done if the patient remain within easy reach of medical aid; if he must go beyond it, iritic adhesions should first be removed. If, in such a case, there are but one or two synechiæ they may be cut through by means of a straight cataract needle, introduced at the opposite side of the cornea and carefully insinuated between the iris and the lens by the side of the adhesion. Free use of atropia should follow the operation. If the synechiæ are of considerable extent, *iridectomy* may be performed. The incision should be made with a keratome just behind the margin of the cornea and the segment of iris removed close to its outer attachment. The iridectomy should be made upward, so as to be concealed by the upper lid.

If complete adhesion of the pupil, or of the posterior

surface of the iris has taken place, the immediate performance of an iridectomy is imperatively demanded. If the pupil is quite clear the operation may be done upward, but if the natural opening is filled with exudation the iridectomy should be done inward, and a little below the horizontal line, so as to give at the same time a new pupil. In such a case it is often impossible to make a clean cut in the iris, owing to the strength of the attachments, which prevent the pupillary edge from being drawn out, but the membrane will tear easily under the forceps, and enough must be removed in this way to get a fair-sized pupil. To defer this operation is often to lose the eye, and the more the vision has become impaired, the pupil being clear, the less benefit is to be expected from the tardy performance. After the lens loses its transparency, there is but little to hope for.

Serous Iritis is attended by all the symptoms of the plastic form, except those dependent upon the adhesive nature of the exudation. There is, in addition, an inflammation of the membrane of Descemet, proliferation of its epithelium, and the consequent appearance upon the inner surface of the cornea of minute, whitish, opaque specks. The aqueous humor soon becomes turbid, and its volume being increased by the serous exudation, the iris and lens are pushed backward, the anterior chamber deepened and the intraocular tension notably increased. This form of disease generally depends upon a depraved state of the health, is not readily amenable to treatment, is often recurrent, and apt to affect both eyes.

Owing to the increased pressure of the fluids on the interior of the ball, atropia is not easily absorbed, and para-

centesis must be performed sufficiently often to relieve the tension and allow the absorption of the mydriatic. As there is no tendency to the formation of synechiæ the administration of mercury is not indicated. Recurrence may be prevented by the performance of an iridectomy, if other circumstances should render the operation advisable.

CYCLITIS, or inflammation of the ciliary body, occurs so rarely, if at all, as an isolated and independent disease, that it scarcely merits description. Its existence is recognized, however, by extreme pericorneal congestion, pain on using the eyes, and tenderness on pressure in the ciliary region.

The IRIDO-CYCLITIS which occurs after injuries to the eyeball is apt to become chronic, to persist for a long time, to affect the choroid, and it is particularly important, on account of its liability to involve the other eye also in destructive inflammation. It may arise from injuries of the ciliary region, from a corneal wound which includes a large part of the iris in its cicatrix, or from a foreign body retained in the eye in contact with either the ciliary body or the choroid. The usual symptoms of plastic iritis assume a chronic form, complete posterior synechia, probably, takes place, the iris atrophies in spots, so that the uvea appears, and dilated blood vessels wander over the surface of the membrane, excessive tenderness is developed in the ciliary region, and in examination of the eye the upper lid must be lifted very carefully, so as not to press upon the ball; the vision is soon limited to mere quantitative perception of light by opacities in the vitreous, the cornea flattens, the eyeball becomes very soft and shrinks, and blindness supervenes. The wasted and sightless ball often remains tender for

years before it excites inflammation in the other eye, or it may produce this result in a month, or finally, all signs of irritation may disappear; but if a foreign body remains within the ball, if bone forms in the choroid, or calcareous degeneration takes place in the lens, renewed cyclitis may be set up at any time, and the sound eye sympathetically affected, to its destruction.

SYMPATHETIC OPHTHALMIA is also an irido-cyclitis and choroiditis. The inflammatory process may commence insidiously, or its approach may be heralded by *sympathetic irritation* of the eye. The latter condition is marked by difficulty in using the eyes for near work, on account of paresis of the accommodation. An attempt to read or sew is followed by congestion of the eyeball and lachrymation. The eye may be unduly sensitive to light, and the field of vision may be contracted, but a more constant symptom is a frequent and transitory failure of vision. This seems to be caused by an inability of the retina to act long without exhaustion, and often seriously interferes with the occupations of the individual.

But the only forerunner of sympathetic ophthalmia may be a gradual failure of the accommodation, or of the acuteness of vision. The symptoms of plastic iritis follow gradually, often without much pain, and the iris becomes everywhere, or at its pupillary margin only, glued to the lens capsule. The signs of inflammation of the ciliary body and of the choroid supervene, followed by opacity of the media and partial or complete destruction of vision, as before described (page 186).

The generally received opinion is, that the disease arises

from irritation transmitted by the ciliary nerves; but Knies has shown a continuity of lymph spaces from the ciliary region of one eye to that of the other, through the sub-choroidal interspaces and the optic nerve sheaths, which would readily permit the transmission of inflammation.

In whatever way the morbid process travels, however, it is generally too late to stop it by removal of the first after the second eye has become actually inflamed. It is therefore axiomatic, that an eye which has been left hopelessly blind after injury should be enucleated (page 168) at once, in order to place the sound eye out of the reach of danger. This is, without doubt, good practice also in the case of those sightless balls which sometimes remain after idiopathic iritis which has run on to cyclitis and choroiditis, especially if such an eyeball is painful, or if sympathetic irritation should arise. If the patient is not seen until the inflammatory process has actually commenced, enucleation of the *blind* eye should be the first step in treatment, as the operation appears, in some cases at least, to exert a favorable influence upon the disease. The usual treatment applicable to corresponding stages of ordinary plastic iritis, especially the administration of mercury, should afterward be pursued. If iridectomy is required for adherent pupil, better results will generally be obtained if the lens, which is usually partly opaque, is extracted at the same time (see *cataract*).

In some cases it is desirable to preserve the blind eye, on account of its normal appearance and the greater inconvenience of an artificial eye, and then section of the optic and ciliary nerves may be performed. A horizontal incision

may be made in the conjunctiva, from the cornea to the outer canthus, and the external rectus caught up, and its tendon divided, control of the muscles being retained by a thread. Scissors should then be introduced, the optic nerve severed, and the ball rotated far enough, by means of the stump of the tendon, to expose the optic nerve entrance. All the ciliary nerves must now be freely divided, the ball returned to position, the tendon reunited by a stitch or two, the conjunctival wound closed and a pressure bandage applied. The objections to the operation are, that hemorrhage is prone to occur behind the ball in sufficient amount to defeat the intentions of the surgeon, or the nerves may reunite and the morbid process go on as before.

If the injured eye retains any useful vision it is not wise to sacrifice it, for if its fellow should be destroyed by sympathetic inflammation it may still serve for many of the ordinary purposes of life.

EXUDATIVE CHOROIDITIS may be either acute or chronic. In the former case the iris also is usually somewhat affected, and there is ocular pain, pericorneal injection, and diminution of the acuteness of vision. The vitreous is at first turbid and opaque, but as it becomes clearer, ophthalmoscopic examination shows more or less extensive patches of whitish exudation, which are evidently located in the choroid, as the retinal vessels pass over them. Or, the retina also may be affected, its vessels partly hidden by serous infiltration, and the optic disk swollen (*choroido-retinitis*). In either case, as the inflammatory action subsides irregular patches of black pigment are deposited in the masses of exudation and the affection becomes chronic.

In most instances, however, there is no acute stage, and the patient seeks treatment simply for failing sight. The recognition of the disease must then depend entirely upon the ophthalmoscope. Large portions of the fundus of the eye are often affected, chiefly in the vicinity of the posterior pole. As the exudation is absorbed, the choroid atrophies and disappears, leaving irregular patches of black pigment only and exposing areas of white sclerotic, around the borders of which there is always a line of pigment. If the retina has been affected the optic disk is atrophied, the vessels shrunken and their course marked by lines of pigment. Often all stages of the disease may be seen in the eye at the same time. In one place, patches of exudation beneath the retina; in others, deposits of pigment, absorption of the pavement epithelium and thinning of the choroidal stroma; in others, more advanced atrophy of the choroid, so that a few only of its vessels, interspersed with pigment, lie upon the sclerotic; lastly, in some places the atrophy is complete, the white sclera being tarnished with pigment and bordered by a black line. If the retina has not been involved, its veins and arteries pursue their course undisturbed, directly across the diseased areas. The vitreous is generally fluid and contains floating, opaque shreds.

Disseminated choroiditis is merely a variety of the affection just described, and differs from it in the fact that the diseased patches are smaller than the optic disk and scattered over the healthy choroid, although several may coalesce, and thus form a larger area. All stages of the affection may be seen in the ocular fundus at the same time, and thus spots in different regions may be black, red,

or white, according as pigment, choroidal stroma, or sclera, are exposed to view. The lighter spots always have a black border of pigment. The affection is frequently congenital, or else it appears at a very early age. It is known as *syphilitic choroiditis* when the patient is the subject of syphilitic infection, as is the case in a large number of instances. In all cases of choroiditis the vision is permanently impaired, and the acuteness is diminished according to the extent to which the macula lutea is involved.

Treatment.—If there are any signs of acute inflammation about the eye, or even patches of recent effusion in the fundus, one or two ounces of blood should be taken from the temple, and the patient should remain in a darkened room for twenty-four hours afterward, to prevent reaction. If there is vascular excitement, a brisk purgative may be administered. Immediately afterward mercurial ointment should be used by inunction, or calomel and opium administered so as to obtain and keep up for a time a slight effect upon the gums. If the affection is chronic, iodoform, grs. ij–v, three times a day, or corrosive sublimate, gr. $\frac{1}{10}$, or potassium iodide, gives good results. If the patient become anæmic the alterative should be suspended and iron administered. The eyes should be protected by London-smoke coquilles, and tobacco and stimulants forbidden. If there is increase of the intraocular pressure paracentesis of the anterior chamber may be performed repeatedly, until the tension becomes normal. No treatment is of any use after atrophy has taken place.

SUPPURATIVE CHOROIDITIS occurs sometimes in consequence of severe injury which involves the iris, especially

if the eye was at the time in a morbid condition. Violent inflammation is lighted up in the entire choroid, or is transmitted to it from the iris; pus forms in the interior of the eye; not only the entire globe, but its appendages become involved (*panophthalmitis*); chemosis of the conjunctiva occurs, with inflammation and acrid or muco-purulent secretion; the iris becomes glued to the lens capsule; the aqueous turbid; the lids red and swollen, and the eyeball fixed by the inflamed tissues of the orbit. There is generally great pain, but sometimes none at all, and seldom the least perception of light. The eyeball may burst and finally shrink, or subsidence of the inflammation and atrophy may take place gradually, without rupture. The disease sometimes occurs as a sequence of cataract extraction, or may arise spontaneously in cerebro-spinal meningitis, or from embolism. If the grade of inflammatory action is not very high, the eye sometimes recovers with useful vision, but most cases are evidently hopeless from the beginning, and treatment is limited to the relief of pain by morphia and warm fomentations. Immediate enucleation affords the speediest recovery.

Tubercle of the choroid is an almost constant accompaniment of acute general tuberculosis, and is therefore of value as an aid in diagnosis. The tubercles are deposited beneath the hexagonal epithelium, mostly about the posterior pole of the eye, and range from one to two-thirds of the diameter of the optic disk. They are readily seen by the ophthalmoscope, as hemispherical prominences which push up the retina and reflect the light brightly from their rounded summits.

The choroid is sometimes *ruptured* by severe blows on the eye, without much affecting the other structures. In such cases the line of rupture may be observed with the ophthalmoscope. Hemorrhages occur from the same cause, or, at other times, without obvious reason. The retinal vessels run over them and thus show their location. Detachment of the choroid from the sclerotic is not often to be seen in the living eye, though common enough as a post-mortem appearance.

CHOROIDAL SARCOMA is the only kind of tumor which takes its origin in this membrane. If rich in pigment, as is often the case, it is called melano-sarcoma. It is mostly a disease of maturity or old age. The first indications of its presence are those of impaired vision. When the cause of this is sought with the ophthalmoscope, the brownish tumor may either be seen projecting into the vitreous, or else it is concealed behind a limited detachment of the retina. As the tumor grows, however, it may again be seen through the retina, and may be distinguished from the choroid by the irregular arrangement of its vessels. If allowed to continue unchecked, it will go on to perforation of the ball, and will appear on the front of the eye as a fungous growth, or will involve the tissues of the orbit and the brain. Early enucleation of the ball, while the tumor is still confined to its limits, affords a fair chance of recovery.

CYST OF THE IRIS is not of very rare occurrence. It is generally the result of injury, or of the presence of a foreign body, and presents itself to view upon the surface of the membrane. As the cyst grows it may interfere with

the functions, or with the integrity of the contiguous parts, and should, therefore, be removed as soon as discovered. An opening should be made in the margin of the cornea, with a keratome, but care should be taken not to puncture the cyst. The wound may be enlarged with scissors, or if more convenient, it may be made in the first place with a Graefe knife. The portion of iris involved must, of course, be removed with the cyst. Other tumors of the iris have been reported, but they are very rare.

Coloboma of the iris and choroid generally occur together, although they may happen separately. The defect is usually congenital and situated in the lower part of both membranes. The fissure of the choroid is visible with the ophthalmoscope, exposes the sclerotic beneath, and runs in an antero-posterior direction.

Irideremia, or complete absence of the iris, is usually the result of injury, and mostly complicated with severer lesions. When it occurs alone, however, the sight may not be much impaired. In a recent case, in my own practice, the entire iris had been torn away by a stick of wood, flying through the air after a blow from an axe. A month afterward the patient had $V = \frac{20}{30}$. His accommodation was good, and he was troubled by direct sunlight only.

CHAPTER X.

DISEASES OF THE CRYSTALLINE LENS.

CATARACT is the name given to an opacity of the lens or capsule. It arises at all periods of life, is even congenital, and is divided into several varieties, according as it occurs first in the nucleus or cortex of the lens, etc.

Cortical Cataract begins in the outer layers, or cortex of the crystalline. There are very few persons in whose eyes the lens, transparent as it is, cannot be seen by means of focal illumination, provided the pupil is fully dilated. The least possible haze marks the surface of the anterior capsule, and faint lines show the divisions between the cortical sectors. If these phenomena are somewhat more pronounced, they may at times be mistaken for incipient cataract. But the lens naturally becomes less translucent as age advances, and the pupil appears to be hazy, even by daylight, although the ocular fundus may be visible with perfect distinctness by the mirror. The change is due especially to increasing density of the nucleus, which acquires also a yellowish hue.

In cortical cataract the opacity generally begins with irregularly disposed striæ, which converge toward the centre of the lens. The patient applies for relief, because of gradual failure of vision, as the striæ increase in number.

If there is no augmentation of intraocular pressure, the pupil may be dilated with atropine, for examination. The eye should then be looked into, at from six to ten inches distance, with the ophthalmoscopic mirror armed with a convex lens of corresponding focus. In this way the lenticular opacities appear black against the red fundus. But with focal illumination the striæ look whitish. Sometimes at this stage the opacity ceases to progress, and it is then called *striated cataract.* Or the turbidity may be composed of minute specks, constituting *punctated cataract.* As the opacity increases the whole cortex becomes cloudy, and the lens swells, pushing the iris forward. After the entire cortex has become opaque, it tends to undergo further change; it softens, and finally becomes fluid. In an aged person, under these circumstances, the nucleus being very hard remains solid and sinks to the bottom of the capsule, constituting *Morgagnian* cataract. With strong focal illumination, if the capsule is not opaque, the nucleus may often be seen to shift its position in the white milky fluid, as the head is inclined. In all cases of fluid cortex the cataract looks milky through the capsule, upon which may be seen white specks. Such cataracts occurring in children finally shrink until the capsule is left with but a thin opaque film between its layers.

When a lens has become everywhere opaque, the cataract is said to be ripe. Inspected by focal illumination, the iris is seen not to throw any shadow on the white lens. If the cataract, or any part of it, seems to be separated from the iris by a dark space it is because just so much cortical substance still remains translucent. *Traumatic* cataract is of

the cortical variety, and is caused by any wound which opens the capsule and admits the aqueous humor. The larger the opening the quicker the change, and the entire lens thus sometimes becomes opaque in a few hours. A slower development sometimes supervenes upon an injury which does not break the capsule.

Nuclear cataract is seldom met with until after maturity, generally about fifty. The senile changes begin early and are pronounced. Sometimes the first symptom of this condition is myopia, caused by some modification in the refractive power of the lens. Such individuals find themselves able to read again without convex spectacles, and are popularly reported as getting their *second sight.* Focal illumination shows the nucleus darker and denser than the cortex. Striæ shoot in from the equator toward the centre. The equatorial regions, however, often remain tolerably clear for a considerable time after the centre is quite opaque, so that, though the patient may be blind with a contracted pupil, he can see tolerably well with a dilated one. Such a patient reports that his vision is best by a dim light. He contracts his brows and bends his head to shade his eyes, so that his pupils will dilate.

If the nucleus is very dark, so that no sign of the disease appears in the pupil to the naked eye, it is called *black cataract.* Even in old nuclear opacities the cortex finally softens, crystals of cholesterin may be seen shining through the capsule, and the lens afterward is partly absorbed and diminished in thickness. Such cataracts are said to be over ripe. Old cases, especially those which have arisen from intraocular disease, sometimes become calcareous.

They are easily dislocated, and may set up iritis, or keratitis, by getting, as they often do, into the anterior chamber. Many cataracts are a mixture of the nuclear and cortical varieties, and a hard nucleus may usually be taken for granted after the thirtieth year of age, if it cannot be made out by focal illumination.

Lamellar cataract occurs in children, is often congenital, and remains stationary. The nucleus and cortical are clear, but a sharply defined, opaque layer is interposed between them. Viewed from the front, by focal illumination, the lamellar cataract appears as a clean, white disk, much smaller than the lens, and situated some distance behind the iris. If the opacity is not too large the patient may have good vision through the clear ring of lens tissue outside of the cataract, within the pupillary edge of the iris.

Posterior polar or *capsular* cataract is generally the result of intraocular disease. The opacity is confined to a small space at the centre of the posterior layers of the lens. *Anterior polar* or *capsular* cataract is limited to a corresponding area of the front of the lens. It may be congenital, but not infrequently develops in consequence of the lens coming in contact with the cornea after a perforating ulcer of the latter. The mere touch seems to cause a change in the nutrition of the cortex, for the opaque substance has been shown by Schweigger to lie beneath the capsule. Prolonged contact produces a thickening of the opacity, which diminishes to a point in front (*pyramidal cataract*).

The cause of cataract is some derangement of nutrition. This may be owing to local disease of the choroid or other ocular structures, as in aggravated cases of myopia and in

glaucoma, or to the increased density of the aqueous and vitreous humors in diabetes. Some cases are due to constitutional causes, as is evident from the rachitic condition of the teeth which generally accompanies lamellar cataract, and from the constant character of senile changes in the lens, but in many instances no cause can be discerned.

The ophthalmoscope has made the diagnosis of the disease easy. It must be borne in mind that the lens lies in contact with the iris, and hence, when the eye is moved, as the ball simply revolves about its centre, opacities in the cornea roll out of the way and allow the lens to be seen. Or, if the opacities are in the vitreous, behind the lens, they are generally floating in the fluid humor, and continue to swim about while the eye is at rest, after a quick movement. Or, if fixed, and behind the centre of rotation, they will go down when the ball is rolled upward, or vice versa.

In considering the prognosis of cataract with regard to the acuteness of vision to be obtained by an operation, the healthy condition of the other intraocular structures is of the first importance. Hence, the appearance of the iris must be noted, whether it dilates readily and fully under the influence of atropia, or whether the pupil is adherent, or there are spots of uvea on the capsule, showing the sites of former adhesions. Increase or considerable diminution of the intraocular tension is unfavorable, as pointing to glaucoma or choroiditis. If there is sufficient clear cortex to allow a view of the fundus, its condition should be carefully studied for indications of disease. The other eye sometimes affords valuable information. If the cataract is quite ripe, however, the sensitiveness of the retina to the

amount of light which it does receive is a good measure of the health of the intraocular membranes. The patient should be able to tell at once if the light of the window is shaded by the hand. If examined with the mirror, the distance to which this may be removed and its reflection still perceived, is a good measure of the degree of sensitiveness of the retina. The condition of different portions of the fundus may be judged by the ability of the patient to point out the direction of the mirror when its reflection is thrown on the eye at various angles. If this test is responded to in a satisfactory manner, the patient is said to have good *light projection.* The length of time which has elapsed since the failure of vision gives some indication of the condition of the lens. If it is uniform and milky in appearance the contents of the capsule are fluid, but if the cataract is mottled or striated the cortex is still firm. Unripe cortical substance interferes with the success of an operation, because it is impossible to tell when it is all removed, and if the capsule is opened in front much of the lens may remain unperceived in the anterior chamber, to afterward set up iritis. Operations on nuclear cataracts may often be long deferred by keeping the pupil dilated with atropia. Black cataracts are not generally favorable subjects for operation.

Treatment.—The medical treatment of cataract is of but slight utility, although measures addressed to the improvement of morbid conditions of the system, as in diabetes, have in some instances apparently checked the lenticular opacity in its incipiency. Commencing cataract, confined to the capsule, has also occasionally been dissi-

pated by a long continued, mild, mercurial course. The details of such treatment must be left to the judgment of the practitioner.

Almost invariably the only means of relief consists in the entire removal of the opaque lens from the eye, and the operation which is best adapted for this purpose, in the great majority of cases, is the *modified extraction*, of Von Graefe. As a general rule, this operation is required in some form in all cases of cataract arising after the age of thirty. It is one of the traditions of ophthalmology, that no cataract should be operated upon until it is ripe, and, without doubt, the operation has at that time the best chances of success. This is because the clear cortex is softer than the opaque, is apt to be scraped off in the exit of the lens and to remain in the anterior chamber, where it cannot be seen at the time of the operation, but where its presence is shown by its becoming opaque in a day or two, and as a foreign body, causing iritis. Later methods, however, tend to render these particles harmless, by retaining them within the capsule, and circumstances often combine to make the operation in an immature cataract desirable It is well, for instance, to operate at once upon the worst eye, in cases where both are affected, and the individual can no longer see his way about, rather than to allow his health to become affected by forced inactivity and the mental anxiety attendant upon prolonged suspense. In some cases, too, of immature cataract of old standing the unripe cortex is sufficiently hard to come away entire, without difficulty. If both eyes are affected with ripe cataracts they may be operated upon at an interval of four or five

days, for in that time all danger is usually over for the first eye. If one eye only is cataractous, the visual field for that side will be enlarged by an operation, and thus accidents to the individual often averted. The case may be stated to the patient, and the decision for or against an operation be allowed to rest entirely with him.

The operation consists of four parts, viz: 1. An incision of the coats of the eyeball, to allow escape of the lens. 2. Iridectomy. 3. Incision of the capsule. 4. Removal of the cataract. Ordinarily, these steps follow in regular sequence, each one being susceptible of some modification to suit particular circumstances, but if there is any increase, or much diminution of the intraocular tension, if the iris is unhealthy, or in some cases, if the cataract is unripe, it is best to perform the iridectomy first and to wait about six weeks, until all irritation has subsided, before completing the operation.

The incision for such a *preliminary iridectomy* may be made with a keratome, if the anterior chamber is not too shallow. The point of the keratome should be entered at the upper edge of the anterior chamber, just behind the corneo-scleral junction, and the blade pushed onward in front of and parallel to the plane of the iris, until an incision of six or eight millimeters long is made. The iris must be drawn out with a pair of iris forceps, and cut off with the scissors close to the ball. If any iris is caught in the angles of the wound it must be gently replaced in the anterior chamber, by means of Wecker's tortoise-shell spatula. The resulting coloboma of the iris should have the shape of a key hole (Fig. 47). A cotton pad and pressure

bandage for three or four days, is all the dressing required. If there has been increase of intraocular tension atropia must not be used. Otherwise, it is well to put a drop or two of a four-grain solution in the eye, after the operation. If the anterior chamber is very shallow the keratome cannot be used, and the point of a linear or Graefe knife may be slipped along in the line of the incision.

FIG. 47.

Unless the patient is of steady nerve, it is best to give ether. The lids should be separated with a stop speculum and the ball held by fixation forceps.

If the *operation of extraction* is to be done at once, the question as to the administration of an anæsthetic must be first considered. If the patient is of steady nerve, and can be relied on to obey orders promptly, it will be more satisfactory to both parties to dispense with ether. The patient must be cautioned to breathe through the open mouth, and above all things to avoid straining. The pain of the incision is not very great, and slight pauses, with closed lids, may be allowed between the steps of the operation. If the administration of ether should be decided upon (chloroform is out of the question, on account of its danger to life), the disagreeable and often disastrous complication of vomiting may usually be prevented by not allowing the patient to eat anything for six or eight hours before the operation. Complete relaxation of the muscular system must be obtained and kept up, until the operation is over.

The patient should be supine, in a good light, with either his feet or the cataractous side toward the window, according to convenience. If the operator uses his right hand he

must stand behind the head of the patient for the right eye, and at his left side for the left. The stop speculum is a dangerous instrument in this operation, and the upper lid should be raised with an elevator, by an assistant, who should be ready to release the lid at the word. With a fixation forceps the operator now seizes the conjunctiva below the cornea, and makes his incision with the linear knife.

The average incision embraces about the upper two-fifths of the circumference of the cornea (see Fig. 47). It may be somewhat larger if the lens is unusually large, and it should be smaller if we have a Morgagnian cataract to deal with. In any event it is better to be a trifle too large than too small. The point of the knife must be entered on the temporal side, exactly in the corneo-scleral junction, and directed toward the centre of the pupil. Having arrived there, the point must be raised and carried across the anterior chamber, close in front of the iris, and made to emerge through the corneo-scleral ring, at a point on a level with that of entrance. With a slight sawing movement the blade should now be made to cut its way out, keeping precisely in the corneo-scleral junction to the last, when the edge should be turned to the front, to cut through the conjunctiva, of which a short flap should be left attached to the cornea.

At this stage the cornea may collapse, or blood may fill the anterior chamber. In the latter case the lid may be dropped for a few moments, and cool water applied. When the hemorrhage has ceased, the blood may be pressed out of the eye by gentle sliding movements of the lower lid, the

upper edge of the incision being at the same time pressed back a little with the tortoise-shell spoon of Von Graefe.

The next step in the operation is the iridectomy. This is required to allow the easy escape of the lens and also to prevent incarceration of the iris in the wound, where it tends to prevent healing, and is always afterward a source of irritation to the eye. It is not desirable to remove a large section of the membrane, but only to destroy the continuity of the sphincter pupillæ. The fixation forceps must now be held by an assistant, while the operator turns back the conjunctival flap with the closed iris forceps (preferably Liebreich's). The iris generally presents itself at the centre of the wound, or, if not, the forceps may be introduced and the membrane seized midway between its attachment and the pupillary margin, drawn out, and a piece about five millimeters wide excised and torn from its insertion, or cut off close to the sclerotic.

If the cataract is overripe, or even if unripe and of long standing, the suspensory ligament of the lens is often atrophied and gentle pressure may be made with the spoon, at the lower margin of the cornea, to see it the lens within its capsule will not present itself at the wound. Such cases are exceptional, however, and the next step is the incision of the capsule. The usual practice is to introduce Von Graefe's fleam-shaped cystitome into the anterior chamber, just behind the free border of the iris, at the lower edge of the pupil, and to make therefrom a clean curved cut in the capsule, along one edge of the coloboma in the iris. Then to insert the instrument again to the starting point of the first cut and make another along the other edge of the

coloboma. Finally, to unite the two cuts by one near the periphery of the lens. The theory of this procedure is, that when the lens is extruded it will bring the piece of capsule thus cut around away with it and leave a perfectly clear pupil. In practice, however, this manipulation is an exceedingly difficult one, and frequently fails. It often results in the making of a few irregular scratches on the front of the lens and in leaving the soft cortical substance ready to be brushed off and retained in the anterior chamber, in the passage of the lens through the wound. A better plan is to make a peripheral incision in the capsule, in the line of the external wound, which may be readily accomplished by a single cut with a cystitome (Fig. 48)

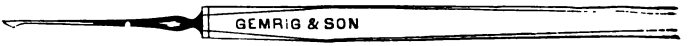

Fig. 48.—Cystitome.

adapted to the purpose. This cystitome is made with a malleable shank, so that it can be bent to suit the brow of either eye. If any soft cortical is retained after this procedure, it is usually enclosed within the capsule, where it can do no mischief. The average final amount of obstruction to vision within the pupil is quite as little, if not less, by this method than by the other, and it is certainly far less disturbing to the eye.

The edge of the lens may now be made to present itself at the external wound by pressing gently with the spoon at the lower margin of the cornea. As the lens advances into the wound the spoon follows it up over the surface of the cornea and receives it as it escapes from the eye. If any cortex remains it may generally be brought into the pupil

by a gentle circular rubbing motion with the lids, and may be pushed out of the anterior chamber by means of the lower lid, the upper one being used at the same time to depress the upper lip of the wound. If the lens does not readily present itself in the wound, the capsule should be again incised. If the lens presents, but does not readily escape, the corneo-scleral wound should be enlarged with the scissors.

It is at this period of the operation that there is the greatest danger of the escape of vitreous. If this is small in amount it is of no particular consequence, but a great loss may be followed by hemorrhage from the choroid, or final shrinking of the eyeball. If the prolapse of vitreous occurs before escape of the lens, the latter should be removed by means of the wire loop, used as a vectis. Afterward a cotton pad and bandage should be applied as quickly as possible.

Finally, the tortoise-shell spatula should be used to replace in the anterior chamber any iris which may be caught in the corners of the wound. This is of great importance in connection with the success of the operation, as one of the causes of consecutive iritis is thereby avoided. Any clots of blood which may remain in the incision, or in the conjunctival sac, must be removed. A drop of a four-grain solution of atropia may be put in the eye and a pad of absorbent cotton and well-fitting pressure bandage applied over both eyes. The patient should remain quietly in bed and the cotton and bandage should be freshly applied in two or three hours, the lower lid being first drawn down a little to allow escape of tears. The eyes should have

clean dressings applied morning and evening, and after the wound has become firm, a retaining bandage may be used. If any mucous discharge appears at the inner canthus, and the conjunctiva is inflamed, a ten-grain solution of borax should be instilled every two hours. If any pain arises, iritis is to be feared, and a four-grain solution of atropia should be applied as often as may be necessary. If any soft cortex appears in the anterior chamber cooling lotions may be used. In some broken-down constitutions sloughing of the cornea, heralded by a puffiness of the lids, takes place. Hot fomentations to the eye and whisky and quinine internally give the patient some chance of recovery.

Under ordinary circumstances the patient should remain quietly in bed, in a darkened room, for two, three, or more days, until the wound has become firm. Afterward he may sit up a little and may be out of bed entirely in five or six days.

The old-fashioned operation of extraction by a corneal flap was objectionable, and has been abandoned, because the violent stretching of the iris, in the passage of the lens through the pupil often resulted in iritis. The iris was liable also to be caught in the corneal wound, and besides the corneal flap had a tendency to slough. Other extraction operations, which left the pupil entire, have the same objections as regards their effects on the iris. Von Graefe's *peripheral linear incision* is objectionable, because it is liable to involve the ciliary body.

The tyro will find it to his advantage to practice operations upon the eyes of dead cats or rabbits before performing them upon his patients.

In all persons under fifteen years of age the cataractous lens may be removed by the *operation of discission* or solution. This depends upon the power possessed by the aqueous humor to dissolve the lens substance. As the lens hardens with years solution becomes more difficult, and after the age of thirty it is generally impracticable. In the performance of the operation, the eye being atropinized, the cataract needle should be introduced through the cornea about half way between the centre and the temporal margin, and two cross cuts, each about one-sixteenth of an inch long, made through the centre of the capsule. A cotton pad and bandage must be applied for twenty-four hours afterward. The next day a little flocculent lens substance may be observed to project from the opening, and as fast as dissolved new cortex takes its place. The whole lens at the same time swells to some extent, and presses upon the iris, which should be retained under the influence of atropia, to keep it out of the way. Some of the flocculent matter may even fall into the anterior chamber, and, if limited in quantity, will occasion no inconvenience. If, however, care is not exercised to make the initial cuts in the capsule very small in size, the lens swells too much and too quickly, protrudes too much cortical substance into the aqueous, and sets up iritis, with its attendant complications.

When lens matter can no longer be seen to project from the wound, the latter should be enlarged and the process will then recommence. The operation may need to be repeated several times, and even the cortical substance loosened with the needle, before absorption is complete. The entire

solution may require from one to nine months, according to the age of the individual, and the pupil should be kept dilated by atropia all the time.

If, before the operation, the cataract can be recognized to be very soft, or almost fluid, a free incision may be made in the capsule, and the contents allowed to escape into the anterior chamber. An incision, a quarter of an inch long, should then be made with a keratome in the cornea, an eighth of an inch or less from the temporal margin, a curette introduced and the aqueous humor and cataractous matter allowed to escape together. If any portion of the iris becomes caught in the wound it should be cut off. A pad and bandage should be applied for a few days, and the patient kept in bed. The influence of atropine should, of course, be maintained throughout the treatment.

In young persons, if the lens substance is not soft enough to run out of a free incision in the capsule, and the iris does not respond well to atropia, the operation of extraction should be performed. If the iris is perfectly mobile, however, the results of discission may be very much shortened by cutting up the lens freely at first. Two needles will be required, one through the nasal side of the cornea, to hold the lens firmly, and the other through the temporal side, to slice up the cortex. Or, the needles may be used alternately for holding and cutting. Atropia, and a pad and bandage, should afterward be applied. The next day the anterior chamber is filled with the broken down and swollen lens substance. As long as the eye is quiet, the softening process may be allowed to go on, but at the least sign of

pericorneal injection, or not later than a week in any event, the anterior chamber should be opened and the cortex and aqueous humor evacuated together as before. If inflammatory symptoms should arise they may be combated by leeching, cold compresses, morphia, etc. A suction tube may be used instead of a curette, to withdraw the contents of the anterior chamber, but is somewhat more dangerous. The after treatment should be the same as heretofore described.

Traumatic cataract is sometimes prevented by the healing of a wound of the capsule, if the injury is very slight. In most cases, however, the cortex is fully or partly opaque, when the patient first consults the surgeon. In young persons the cataract will gradually be dissolved by the aqueous and disappear. Inflammatory reaction must be subdued by cold compresses, leeches to the temple, atropia and ocular rest. Loose cortical in the anterior chamber should be removed by the keratome and curette. If a foreign body, as a chip of steel, has entered the eye and remains in the lens, the latter should be removed by the modified extraction operation. A traumatic cataract in a person past thirty is unlikely to be absorbed, and should be extracted, preferably before inflammation occurs, or after it has subsided.

The treatment of lamellar cataract depends upon its size and the condition ot the peripheral cortex. As a general rule, in all cases of central opacity of the lens, nothing should be done in the way of operation if vision sufficiently good for the ordinary purposes of life can be obtained by the methodical use of atropia. This will generally require the employment of spectacles to supplement the accommo-

dation for near vision. If the central opacity is too large, however, to admit of relief in this way, and the peripheral portion of the lens is perfectly clear, an artificial pupil may be made by iridectomy. But if the periphery also is of impaired transparency, it is better to perform discission.

SECONDARY CATARACT is the term applied to those opacities which form in the pupil some months after an operation for the removal of primary cataract. It is of all degrees of density, from the cobweb film, which can be discerned by focal illumination only, to the white membrane, which is evident by diffused daylight. It is due to inflammatory proliferation of the cells of the capsular tissue. The resulting opacity is increased if the iris also is involved with the production of plastic exudation. It looks as if it might be easy in such cases to make an opening in the cornea, introduce a pair of forceps, and tear away the obstructing membrane, but the latter is generally strongly adherent to the iris, and violent inflammation is liable to supervene. The method generally pursued is to tear an opening in the centre of the opacity by means of two needles introduced at opposite sides of the cornea. A better plan is to insert a stop needle (Fig. 49), through the nasal side of the cornea and the central portion of the cataract, to hold the latter steady, while a Hay's needle (Fig. 50), introduced through the temporal side of the cornea, is used to slit the cataract in several directions outward from the stop needle. If these procedures are not successful, or if the membrane is thick, an incision one-fourth of an inch long may be made in the upper part of

FIG. 49.—Stop Needle.

FIG. 50.—Hay's Needle,

the cornea, an eighth of an inch, or less, from the margin, by means of a keratome. The point should be pushed obliquely downward through the pupil, into the vitreous. Into the corneal opening Wecker's scissors (Fig. 51), should be introduced, closed. When the point arrives at the pupil the blades are allowed to open, and one is passed behind, the other in front of the iris, which is to be divided directly downward by a single cut. The sphincter pupillæ instantly retracts and a clear, triangular pupil results, (Fig. 52). This is the operation of *iridotomy*. Atropia should be put in the eye, a pad and bandage applied, and rest enjoined for a few days.

Fig. 52.

Fig. 51.—Wecker's Scissors.

Aphakia, or the condition of the eye after the loss of the lens, requires a strong convex glass, usually about $+\frac{1}{4}$, for distant vision. As the power of accommodation also departs with the lens, about $+\frac{1}{3}$ is generally required for reading, or sewing, etc. These values, however, must be determined by actual experiment in each case. There is often considerable astigmatism also, from retraction of the corneal cicatrix, and the visual acuteness can be greatly increased in such a case by the proper combination of a cylindrical with a spherical lens Some cases of aphakia have been reported, in which the accommodation was in some degree retained. This may be supposed

to be owing to the effect of the simultaneous action of the recti muscles in laterally compressing and thus elongating the eyeball.

Luxation of the lens may be congenital, or it may arise from injury. In such a case the iris is seen to be tremulous immediately after any motion of the eye. This symptom arises from the fact that if the lens is displaced, some portion of the pupillary margin of the iris must be left unsupported. Often the lens is sufficiently dislocated for its periphery to become visible in the pupil by means of the ophthalmoscope. With the mirror at eight or ten inches distance, the edge of the transparent lens appears as a dark, curved line on the red background of the fundus oculi. The treatment must depend upon the position of the crystalline. If the latter is displaced and fixed, so that a portion of the pupil is aphakial, the vision may often be improved by the adaptation of a proper convex lens. If the lens is loose, and acts as a foreign body, it should be extracted at once, before inflammation occurs. After the usual incision and iridectomy, the wire loop should be used to remove the lens in its capsule. If the lens has slipped into the anterior chamber a cataract needle should be thrust in behind, to prevent it from slipping back through the pupil when the corneal incision is made. In some cases of injury the eye is ruptured at the corneo-scleral junction, and the lens escapes under the conjunctiva, where it is readily recognized by its form. There is singularly little irritation accompanying this condition. The lens should not be disturbed until the corneo-scleral rupture has firmly healed, when an incision through the conjunctiva will be sufficient for its removal.

CHAPTER XI.

DISEASES OF THE VITREOUS.

The vitreous body is not absolutely clear and transparent, and in the most healthy eyes motes may be seen subjectively, by looking through a pin hole, in a card, at a white cloud. Interruption of the delicate pencil of light thus produced is readily made evident. Under ordinary circumstances, however, in the healthy eye, only those opaque elements of the vitreous which lie near the retina throw shadows thereon, when the eye is directed toward a bright, white surface. These shadows are known as *muscæ volitantes*. They always keep their positions relative to the point of fixation, and elude the direct gaze. They appear as rings or filaments of various shapes, and are especially common in myopia, when, in consequence of being better defined than the images of external objects, they often occasion much annoyance. A properly adapted concave lens, however, dispels them, by causing vision to be more distinct. Such shadows are of no consequence unless they are evidently increasing, or the opacities causing them can be discerned by ophthalmoscopic examination through the dilated pupil.

The *hyaloid artery*, which in the fœtus runs from the disk to the lens, persists in rare cases during after life, and can be perceived with the ophthalmoscope. New blood

vessels may be developed in the vitreous after old choroiditis, but are of no consequence, except as a pathological curiosity, in an eye already blind.

The external portions of the vitreous are naturally of firmer consistency than those at the centre, but in old age the whole humor liquefies, from fatty degeneration of its elements. This *synchysis* results also from inflammatory or atrophic affections of the choroid; the fluid contains floating opacities, and the ball becomes softer than natural. In a condition known as *sparkling synchysis* the fluid vitreous contains floating crystals of cholesterin, which glitter like grains of gold under ophthalmoscopic examination, and are whisked about by the movements of the eye. They are not usually permanent.

Hyalitis, or inflammation of the hyaloid membrane, occurs as an accompaniment of other inflammatory affections of the eye, especially retinitis and choroiditis. It is known by its effects only in causing the vitreous to become turbid and fluid. This turbidity results from proliferation of the cell elements, which causes the formation of opaque masses or membranes. These may be either floating or stationary, and, of course, diminish greatly the acuteness of vision by interposing between the pupil and retina. They are readily seen in the erect image with the ophthalmoscopic mirror at some inches distance, armed with a lens of appropriate focal length, and are most conspicuous when floating. They may be seen in the inverted image also, by moving the objective lens further from the eye after focusing the retina. If treated while still of recent origin these opacities may often be cleared up, especially when the re-

sult of syphilitic inflammation, but old opacities are mostly permanent. The treatment must be directed to the cause, and if this cannot be ascertained leeches or blisters to the temple, cathartics and the preparations of mercury or iodine may be of benefit.

Hemorrhage into the vitreous comes from the retinal or choroidal vessels, and in the latter case is usually accompanied by a localized detachment of the retina. A hemorrhagic opacity, unless very small, is difficult to see with the ophthalmoscope, and often makes it impossible to light up the interior of the eyeball. No reflex can be obtained. This fact, coupled with the sudden origin of the blindness, often occurring within an hour, makes the diagnosis easy. Such cases are often apparently causeless. Absorption, with return of the acuteness of vision, takes place slowly, after some weeks. There is always a possibility of recurrence of the hemorrhage, however, with permanent loss of sight through detachment of the retina.

CHAPTER XII.

DISEASES OF THE RETINA AND OPTIC NERVE.

The retina is subject to inflammatory action of several types and from a variety of causes. It becomes *hyperæmic* in diseases of other parts of the eye or as a reflex phenomenon, especially in affections of the genital organs. This condition is characterized by undue redness of the optic disk and dilatation of the retinal veins.

ALBUMINURIC RETINITIS is a not uncommon affection, and its detection is often the first intimation of the existence of Bright's disease. It occurs, however, in six or seven per cent. only of all cases of that malady, principally in the chronic form, and is a mere symptom of the constitutional condition which gives rise to the renal disease. It always affects both eyes, and the attention of the patient is usually directed to it by the failure of vision. Ophthalmoscopic examination shows swollen and tortuous retinal veins. The optic disk is more or less red and swollen, and its edges ill defined or entirely hidden. A haze or cloud veils the adjacent retina. Red patches of effused blood often hide portions of the vessels and gleaming white spots, striæ or patches are arranged, often in a radiated manner, around the macula or between it and the disk. These white spots are due to fatty degeneration of the retinal tissue or to sclerosis of the nerve fibre layer.

They were at one time thought to be pathognomonic of Bright's disease, but are now known to occur in other affections, so that an examination of the urine is always necessary to confirm the diagnosis. The retinal vessels may be seen to run under or through the spots, and thus show their location. In cases of some duration, white lines, caused by proliferation of the tunica adventitia, accompany the retinal vessels. In elderly persons whitish spots of sclerosed or degenerated retinal tissue are sometimes to be seen about the macula when no albumen can be discovered in the urine. Impaired sight, or health, or both, have perhaps led to the ophthalmoscopic examination. In such instances casts of the renal tubules can generally be detected in the urine on careful examination, and albumen makes its appearance finally. Cases arising in the acute form of the disease sometimes clear up entirely, but the prognosis is generally most grave, and treatment must be adapted to the renal disease.

PIGMENTARY RETINITIS is usually discovered in consequence of the complaints of the patient, that he cannot see in the twilight, or after dark (*hemeralopia*). The retina requires the full stimulus of daylight to make it act. In addition to this, the field of vision is contracted and lessens in dimensions as the disease progresses, until at last, even the centre disappears, and blindness supervenes.

A rough estimate of the *visual field* is readily made. If the right eye is under examination, the patient fixes it, at a distance of eighteen or twenty inches, on the left eye of the surgeon, who is opposite him, and who can in this way notice the slightest deviation in the gaze. The other

eyes of the patient and surgeon being closed, the latter may move his hand in all directions from the periphery toward the centre of the field, in a vertical plane half-way between the two faces. The surgeon may, in this way, compare the patient's visual field with his own, and thus judge of any contraction of the former.

A more accurate, and at the same time an expeditious method, is by means of a vertical blackboard. The patient should be so placed that the eye under examination (the other being closed) is opposite, and ten or twelve inches distant from the centre of the board, where a white spot marks the point of fixation. The head may be kept steady by a stick placed between the forehead and the board, and the surgeon should stand where he can watch that the patient's eye does not deviate. A small piece of chalk, fixed in the end of a black rod, may then be moved from the edge toward the centre of the board, and as soon as the white color is perceived by the patient, a mark may be made at the spot. All other directions may be quickly tested in the same manner, and the marks being joined together by a line, give the periphery of the field. As the blackboard is divided into squares by permanent equidistant lines, which cross it at right angles, a miniature copy of it on a slip of paper serves for making easily an exact copy of the field. This should be preserved for future reference.

A somewhat more accurate instrument is the perimeter. This is a metallic quadrant, arranged to rotate about one of its ends so as to describe a hemisphere, of which the eye under examination is the centre. The point of rotation of

the quadrant is made to coincide with the projection of the optic disk in the visual field. The measurements are then taken on the quadrant and transferred to an appropriate diagram ruled in radii and concentric circles. This plan has the advantage that the test object is everywhere at the same distance from the eye, and that a larger field may be examined. The process, however, is a tedious one, and, in consequence of the interference of the nose and brow, does not measure the entire field. Besides, the blackboard usually gives a sufficiently large field for all practical purposes.

In the early stages of a case presenting night blindness and contracted field the ophthalmoscope will show, at those parts of the retina near the equator of the eye, numerous black spots with irregular stellate projections, not unlike the microscopic pictures of bone corpuscles. These follow to some extent the lines of the blood vessels. As the case progresses the pigment patches make advances toward the macula, the retinal vessels become more attenuated, the disk whitens and sinks, the retina becomes hazy, and when the macula is involved blindness occurs.

The disease consists of localized patches of inflammation, in which the nervous tissue is atrophied and the connective tissue and choroidal pigment epithelium proliferated. It may last twenty years before producing the inevitable result. The cause is unknown, but the malady may be hereditary, or at least is liable to affect members of the same family. Little can be done in the way of treatment except to keep the patient under the best possible hygienic conditions. Electricity may be tried.

Syphilitic Retinitis, like some other diseases of the eye which are due to syphilis, must depend for its diagnosis largely upon the history of the case. The patient's attention is attracted to his eyes by failing sight only. The ophthalmoscope discloses swollen and tortuous retinal veins, which are more or less hidden by a fogginess of the posterior portion of the retina, especially around the disk, and by grayish patches of very irregular shape, which are scattered over the fundus. The vitreous also is often somewhat hazy. Local treatment is of little avail, and therapeutic measures must be directed to the constitutional condition. If the case is seen early, before destructive changes have taken place in the nervous elements, vision may be restored.

Retinitis may also arise from exposure to cold or from looking at the sun. The ophthalmoscopic picture presents a swollen and foggy retina, often with striated opacity, especially about the disk, which also is hyperæmic and cloudy. The veins are enlarged and tortuous. The extent to which vision is affected depends on the condition of the macula. The affection generally yields slowly to local and general treatment. Leeches to the temple, purgation, potassium iodide, and rest of the eyes are the principal therapeutic measures indicated.

Retinitis of the macula lutea has been described as a separate form of disease. The choroid, however, is chiefly affected, and the nervous coat secondarily. The disease is generally ushered in with much ocular pain and dimness of vision. The ophthalmoscope shows a bright red fovea centralis, surrounded by a ring of milky retina, of variable

width. Outside the ring the white opacity shades off into the healthy retina, often interspersed with hemorrhagic patches. The infiltration disappears after a time, but the disk and vessels become atrophic and a permanent central scotoma is generally left in the visual field.

Retinitis occurs also in rare cases of *leukæmia*. The ocular fundus presents a yellow appearance. The retina is foggy and dotted with white clusters of lymph corpuscles and hemorrhagic patches. White blood corpuscles also arrange themselves in lines along the sides of the retinal vessels.

HEMORRHAGES into the retina are readily recognized by means of the ophthalmoscope. If they occur on the inner surface of the membrane, they appear as red patches, with clear cut margins, and all vessels evidently pass beneath them. If the patches are in the retinal tissue, they are mostly smaller and the edges blend with the surrounding color. Hemorrhages in the vicinity of the disk are most likely to be superficial, or to spread through the nerve fibre layer in a somewhat striated manner. Blood effused on the surface of the membrane may interfere more or less seriously with vision, in proportion as the patches approach or cover the macula lutea. The effusion, if small in quantity, usually undergoes absorption in a month or so, often leaving a white deposit of fibrin in its place for some time. But if the amount of hemorrhage is considerable, inflammation (*hemorrhagic retinitis*) is pretty sure to set in, and subsides only to leave the optic disk more or less atrophied, and the retinal tissue infiltrated with pigment from the pavement epithelium. Or, the intra-ocular tension may increase and the eye become glaucomatous.

When blood is effused into the retinal tissue, more or less disorganization of its fragile constituents is unavoidable, inflammation follows, and the injury to vision is permanent if the macula is involved. The condition called *metamorphopsia* often results after complete absorption has taken place. Letters and other objects assume a wavy or irregular appearance, probably in consequence of a disarrangement of the rod and cone layer. Hemorrhages occur in consequence of inflammation, as before stated, but they may arise from any cause which produces local congestion, from diseases of the circulatory system, or from changes in the constitution of the blood. Hence atheroma, Bright's disease, epilepsy, straining, scurvy, purpura, leukemia, essential anæmia, optic neuritis and cardiac hypertrophy, are all causative, and the occurrence of retinal hemorrhage often serves as an aid in the diagnosis of these diseases.

The treatment must depend largely upon the condition of the system, but if there is local inflammation the usual local remedies will, of course, be applicable.

OPTIC NEURITIS can be recognized by the ophthalmoscope only. There may be no diminution whatever in the acuteness of vision, or the failure of sight may be sudden and almost complete. As a general rule, however, the vision suffers a gradual impairment, which leads to an examination and a discovery of the condition of the nerve. The disk appears more or less swollen, its surface congested and foggy, the lamina cribrosa is no longer visible, and the choroidal and scleral rings, which mark the edge of the disk, are lost to view behind the cloudy swelling of the intraocular extremity of the nerve. The opacity of the

disk is often marked with radiating striæ, due to the course of the nerve fibres, which give it something of a wooly appearance. The veins are dilated and tortuous, and the arteries more or less contracted, but much of the course of the vessels is lost in the swollen tissue, a knuckle only projecting here and there. White patches of fatty or sclerotic degeneration may often be seen on the swollen disk and striated effusions of blood in the puffy retina in its vicinity. If the inflammation extends into the retina to a considerable extent the condition is called *neuro-retinitis*. When the retina is not at all involved and the swelling of the disk is very great, with extreme tortuosity of the veins, it is known as a *choked disk*. In all cases the degree of swelling of the extremity of the nerve may be measured by comparing the strongest convex or weakest concave lens by which the summit can be seen with the strongest convex or weakest concave lens through which the adjacent healthy retina is visible. The difference between the values of the lenses may be translated into millimeters, if desired, by means of one of the tables constructed for the purpose.*

Neuritis may be of all grades and periods of duration. It may come and go without leaving a trace, or it may terminate in atrophy and blindness. In cases of inflammation of the optic nerves (*retro-bulbar neuritis*), the congestion of the disk may last for a few days only and be followed by blindness with dilated pupil. Or, if more chronic, all the symptoms of neuritis in a very light form may exist for a considerable time before the disk finally atrophies.

Microscopic examination of a section of an inflamed disk

* Loring, p. 335, *American Journal of Medical Sciences*, April, 1870.

shows that the swelling takes place laterally as well as forward into the vitreous, and thus overlies the retina to some extent. The tumefaction is due to proliferation of the connective tissue, œdema, hypertrophy of the nerve fibres, pushing forward of the lamina cribrosa, and to the development of new blood vessels. The failure of vision is in proportion to the amount of change in the nerve fibres.

The cause of the neuritis cannot always be determined. In general it is symptomatic of some intracranial disease, such as inflammation of some sort. Choked disk is usually looked upon as indicative of the existence of a tumor of the brain, but it may depend upon local interference with the circulation. Depraved general conditions of the system, such as syphilis and lead poisoning, may produce optic neuritis. It may also result from local or general disturbance of the circulation, diseases of the orbit, and affections of the spinal cord.

The treatment must be adapted to the cause, as far as that can be ascertained, and cases which are traceable to syphilis, congenital or acquired, afford the most favorable prognosis. Leeching and counter irritation are often beneficial as local measures. Iodoform is frequently very useful as an alterative and absorbent, in alternation with mercury or the potassic iodide. It may be given in two to five-grain doses, in pill form, after each meal. If no cause can be discovered, the affection should always be treated upon the assumption of syphilitic infection. The mercurial impression should be produced as quickly as possible, the drug being administered by inunction and by the mouth at the same time. The slightest effect upon the gums is sufficient,

and the quantity of the medicine should be at once diminished, but the administration continued, so as to keep up the impression for some weeks. If the disease show no signs of yielding, either in the increase of the acuteness of vision, or in the decrease of the morbid ophthalmoscopic appearances, the mercury may be stopped and iodoform prescribed. After several weeks this may be replaced by potassium iodide, which should always be taken in plenty of water, before meals, and in as large a dose as can be borne, short of producing iodism; such a dose may be anywhere from two to sixty grains. This may be followed, in order to keep up the impression for a long time, by the protiodide of mercury, in doses of one-third of a grain, or by corrosive sublimate and ammonium chloride, of each one-sixteenth of a grain in solution, three times a day. If at any time in the course of the treatment the patient become pallid and cease to improve, the alterative should be stopped and full doses of iodide of iron administered. If no improvement accompanies the alterative treatment, the Turkish bath, taken two or three times a week, often has a very happy effect. The use of alcohol and tobacco must, of course, be strictly forbidden, and the patient must keep regular hours and allow plenty of time for sleep. If the disorder begins slowly to yield under treatment, it is often a good plan to alternate the remedies above mentioned, returning to the mercury at intervals after its effects have entirely disappeared, in this way dealing the disease successive blows, each one falling while the malady still reels under the effects of the last.

OPTIC ATROPHY is the natural result of neuritis, although

cases do occur in which there is apparently no previous stage of inflammation. Under ordinary circumstances of neglected or incurable neuritis, however, as the swelling and congestion decrease, the disk grows whiter, the acuteness of vision diminishes and the visual field contracts. As the hypertrophied nerve fibres atrophy, the fine vessels which gave vascularity to the disk shrink and disappear, the proliferated connective tissue contracts, or is absorbed, and the disk is left white and sunken. This change occurs first always on the temporal side, where the nerve fibres are fewest in number, and thus a disk may often be seen with the temporal half undergoing incipient atrophy while the nasal half is yet wooly and hyperæmic. If there has been little or no connective tissue proliferation, or no previous neuritis, the lamina cribrosa is apparently laid bare, and the openings which give passage to the bundles of nerve fibres become unusually conspicuous as bluish dots. Or, the whole disk may assume a bluish tint in old cases. The appearance of the retinal vessels depends much upon the previous condition of the disk. In any case they become more or less contracted and the arteries more so than the veins. In some instances the former are reduced to mere filaments, or even disappear beyond the limits of the disk. But, if there has been previous neuritis, with much swelling, the veins long retain some traces of fullness and tortuosity.

The contraction of the visual field is, perhaps, the best measure of the extent of the atrophy in the nerve fibres, and this contraction is especially marked in the fields for the different colors. Fig. 10, page 22, gives the normal

fields for white and colors as taken with the perimeter, and if the general field does not appear to be diminished, when tested on the blackboard (see page 220), the fields for blue, red and green, on account of their smaller size, often afford a ready method of detecting abnormal conditions. The limits of these fields are determined by means of bits of colored paper, or worsted, or the end of a wire or black rod. The contraction usually commences in the same part of the field for both eyes, although frequently the affection does not begin in both at the same time. The limitation often shows itself first in the upper and outer parts of the field, although it may begin anywhere. After contraction has proceeded to a considerable extent, central vision is attacked and blindness quickly supervenes. The duration of the process is quite uncertain. It may last for years before complete extinction of vision, or sometimes it may be arrested at any stage, and lost ground even recovered, under appropriate treatment.

The causes of optic atrophy are those of neuritis, but some cases occur apparently without preceding inflammation, as when the optic nerve is severed by injury, etc. When symptomatic of disease of the spinal cord there is impairment of use and sensation in the lower limbs, with contracted pupil and often loss of the patellar reflex. The mottled gray atrophy, described by Virchow, is indicative of a similar change in the spinal marrow. Some cases of atrophy appear to be confined to the disk itself.

The treatment must be governed principally by the considerations which affect optic neuritis. In some instances of deep physiological cup, the subsequent atrophy may

simulate glaucomatous excavation, but this complication may be considered as eliminated if the intraocular tension is not increased. If there still remain signs of undue vascularity, *i.e.* a wooly appearance of the disk or tortuosity of the veins, and there is any reason to suspect the existence of a syphilitic taint, the treatment described as appropriate for this malady as a cause of neuritis may be instituted. Afterward, when the vessels become contracted, sulphate of strychnia may be employed. It may be given in gradually increasing doses, either by the mouth or hypodermically, to the point of intolerance, as indicated by twitching of the muscles, especially of the extremities. The dose may then be lessened a little, bu the influence of the medicine maintained for some time. The drug may also be employed as a collyrium, in a solution of four grains to the fluid ounce, of which two or three drops may be placed in the eye five or six times a day.

AMBLYOPIA is that condition of impaired vision which is neither dependent upon anomalies of refraction nor upon perceptible changes in the ophthalmoscopic appearances of the fundus oculi. It is often congenital, and as previously stated, is apt to accompany high degrees of ametropia, and to be complicated with strabismus. It persists after the defect in refraction is fully corrected by appropriate glasses. It may occur congenitally in emmetropia, but is somewhat rare.

It arises *de novo* in deranged conditions of the nervous system, such as hysteria (*hysterical amblyopia*), partial paralyses, spasmodic affections, and sometimes in women and children, without apparent derangement of the general

health. In these cases there is often also undue sensitiveness to light. If the vision of the patient is tested by a variety of methods, the results are often contradictory, and the physician feels some doubt as to the reality of the disease. Treatment requires attention to the nervous system, and in cases of apparent health the administration of tonics, especially quinine and arsenic. Protecting glasses should be prescribed for the relief of photophobia.

HEMERALOPIA (night blindness), is a form of amblyopia which occurs under conditions of defective illumination only. The vision is good enough by daylight, for instance, but fails far more than is natural as night approaches. The defect seems to consist largely in a contraction of the visual field, and failure of the color sense, which is directly proportionate to the dimness of the light. Both eyes are affected. The disease may be congenital, or it may arise in persons of impaired nutrition, who are exposed for some time to excessive light. It thus affects our soldiers on the Western plains after marching in winter over vast snow covered surfaces (*snow blindness*). Sailors in the tropics are also liable to it, and as they cannot see by night, they call it *moon blindness*. In both cases conjunctivitis, if it accompanies the affection, is a mere incident. The malady can be prevented by wearing, when exposed to the cause, dark protecting glasses, or a cardboard screen for each eye, with a pin hole opposite the pupil. Normal vision returns under the influence of good nourishment, tonics and ocular repose.

Another form of amblyopia, which affects both eyes, arises from excesses in venery, in the use of alcohol or tobacco, in

loss of sleep, etc. Hence it has been called *amblyopia potatorum, tobacco amblyopia*, etc. It is possible that one form of excess alone is unlikely to produce the affection, and the above mentioned causes are very frequently conjoined. There is so often a diminution of vision confined to the centre of the visual field (central scotoma), in these cases, that it has been considered as diagnostic. The central scotoma, when it exists, may be measured on the blackboard, and is often detected by the absence of color perception, while that for light and form may be intact. The scotomata for the different colors will be found to vary in size. The disease occurs nearly always in men. Although the ophthalmoscopic picture is generally perfectly normal, yet cases do present themselves in which there is slight optic neuritis, followed at a later stage by partial atrophy of the disk. In such instances there is supposed to be a retrobulbar neuritis. The prognosis is favorable if the disk is normal, if the visual field is not contracted, and if the patient can be induced to abandon his bad habits. If there is any neuritis, leeches, or the Heurteloup apparatus, may be applied to the temple, and a cathartic administered. Under other circumstances the bromide and iodide of potassium in full doses are advisable.

AMAUROSIS is a complete blindness with normal ophthalmoscopic appearances at the fundus oculi. It has been wittily defined as a condition in which neither the patient nor physician sees anything. Before the invention of the ophthalmoscope many cases were classed as amaurotic which are now known to arise from disease of the ocular tissues. The typical form is that which occurs occasionally

in the course of Bright's disease, and is known as *uræmic amaurosis*. It may arise in a perfectly normal fundus, or may be incidental to albuminuric retinitis. It is usually associated with other indications of uræmia, such as headache, nausea and vomiting, convulsions, etc., and the sight fails more or less rapidly, ending in total blindness. This, however, is generally a transient condition, and so long as the iris is sensitive to the influence of light, the vision may and usually does return. If the pupil become immovable, however, and the blindness lasts longer than a month or two, there will be evidence of organic disease in the disk, ending in atrophy. Other cases of amaurosis usually depend upon lesions within the cranium, and are hopeless if the disk shows signs of commencing atrophy.

Amaurosis is sometimes feigned by soldiers who wish to escape duty, by hysterical women, or by persons who have sustained some trifling injury but desire to claim damages. In amaurosis of both eyes from other cause than uræmia, the pupil is always somewhat dilated and immovable, but the dilatation is not the complete mydriasis of atropia. Therefore, imposition can be detected by testing the action of the iris under the influence of alternate light and darkness. If one eye only is claimed to be blind, and the ophthalmoscopic appearances are normal, a prism of 10° or 15°, with its base upward or downward, as recommended by Von Graefe, may be placed before the healthy eye, the other remaining open. The individual is now asked if this improves his vision. If he reply that he sees double the deceit is, of course, exposed. If he deny diplopia the base of the prism should be turned in-

ward or outward and notice taken whether a corrective squint arises. A variety of tests which naturally suggest themselves may be made with the stereoscope. Under no circumstances should the person be allowed to perceive that simulation is suspected. He should be prevented from seeing the slide before it is placed in the apparatus. The picture before the healthy eye may be blackened, or a circle may be placed before one eye and a cross before the other, etc.

COLOR BLINDNESS is a congenital lack of the perception of colors. It may be complete for one or more colors (*achromatopsia*), or the perception may be only slow and difficult (*dyschromatopsia*). The most frequent form is blindness for red, the next is for green, the most rare is for blue. About five per cent. of all men are affected, but much less than one per cent. of women. The individual is unconscious of the defect, and generally escapes remark by being able to distinguish colors by the difference in the intensity of the light simply. As before stated (page 22), the perception of colors in the normal eye is limited to certain portions of the retina. This is true, however, of ordinary pigments only under ordinary conditions; but Landolt has shown that "all colors are recognized up to the limits of the field of vision, if they are of sufficient intensity." The usual method of testing color blindness is by means of small skeins of worsted yarn of all colors and shades. A purple skein is given to the patient and he is told to select all the shades of the same color. If he add blue or violet to the purples, he is red blind. If green or gray, he is green blind. If red or orange, he is blue blind.

HEMIOPIA is an amaurosis confined to a lateral half of the retina, and usually affects the same side in both eyes.

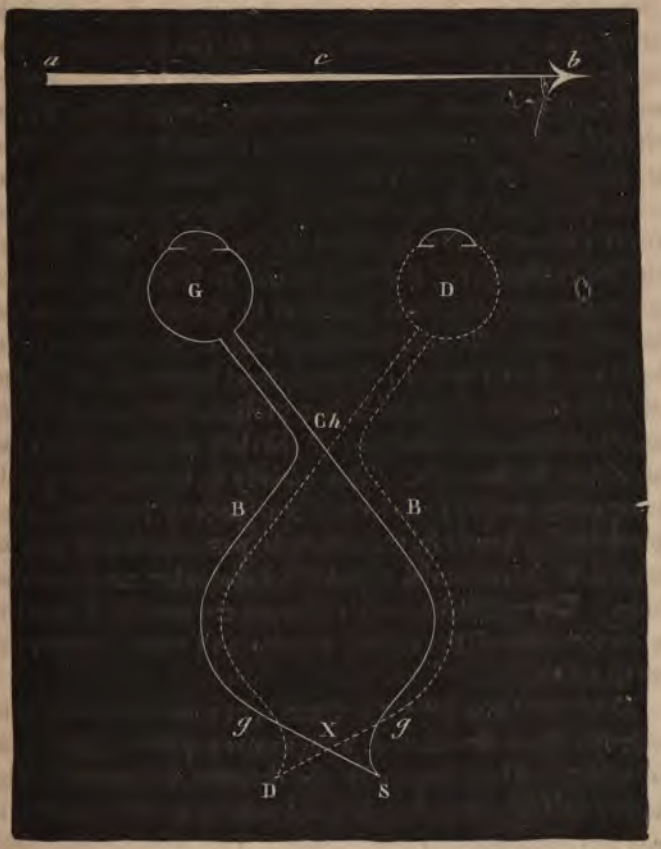

FIG. 53.—Mode of Decussation of the Optic Nerves.

The consequence is an obliteration of that half of the visual field which is opposite the affected side of the retina. The

division is made vertically, and a sharp line running through or near the point of fixation separates perfect sight from blindness. Sometimes less than one-half of the field is affected. The cause usually lies in the brain, or in the optic tract behind the commissure. There is a semi-decussation of the nerve fibres in the commissure (Fig. 53), so that if there is a lesion involving one optic tract the corresponding halves of both retinæ are affected. Let G represent the left and D the right eye. The optic nerve fibres from each organ are supposed to be traced back through the commissure *Ch*, the optic tracts B B and the corpora geniculata *g g*, to points S and D in the opposite cerebral hemispheres. Then it is evident that a neoplasm or other lesion at B or *g* would produce lateral hemiopia, at *Ch* loss of vision in the temporal halves of both fields, at X in the nasal halves, at S blindness of the left eye, and at D loss of vision in the right. The malady is sometimes purely temporary, arising from some disturbance of the circulation. Frequently, however, the defect is permanent and may be traced to intra-cranial syphilitic, tubercular, or other disease. The ophthalmoscopic changes are usually limited to a contraction of the retinal arteries and some hyperæmia of the disk.

DETACHMENT OF THE RETINA, in consequence of fluid effusion from the choroid, also causes a defect in the field of vision. Most frequently the detachment occurs in the lower half of the retina, and the patient is then unable to see anything above a certain line. The effusion may take place anywhere, however, but even if it occurs in the upper part, the force of gravity finally causes the fluid to work

its way below, and the portion of the retina first detached may become adherent again. Examined through a dilated pupil, by the ophthalmoscope, it will be seen that the ordinary red reflex is gone from the part affected. The detached portion is mostly of an opaque gray or greenish gray hue, evidently projects forward into the interior of the eye, and is crossed by folds or wrinkles. The retinal vessels follow all the sinuosities of the surface and appear darker than usual. If the detachment is quite recent, the retina has not yet become opaque, but is seen, however, to be already somewhat hazy. If the detached portion is large, and the vitreous is fluid, as is usually the case, the membrane floats about loosely when the eye is moved. Even with total detachment there is usually light perception for some time, but atrophic changes soon disorganize the delicate nervous structures. The malady occurs most frequently in high grades of myopia, probably in consequence of choroidal disease. It may arise in emmetropia, however, and is often the natural sequence of severe injuries to the eyeball. It may arise from a derangement of the secretory nerves, resulting in a permanent diminution of the amount of vitreous humor, indicated by a decrease of the intraocular tension. In rare cases absorption of the effused fluid, with reposition of the membrane and return of vision, takes place; but generally the case goes on from bad to worse, and ends in blindness. The operation of puncturing the retina to allow escape of the effusion into the vitreous has not been sufficiently successful to make it of any value. Puncture of the sclerotic has been recommended, but probably the best plan is to keep the patient quiet in bed, with

a protective bandage applied over the eye, and to use mild derivative treatment for the accompanying choroiditis.

GLIOMA is the only kind of tumor which occurs in the retina. It arises almost exclusively in very young children, and the attention of the parents is usually attracted to it by the appearance of a white or yellowish white reflex in the pupil. This leads them to examine the eye, and it is then discovered to be blind. In the rare cases in which the growth has been traced from the beginning in older persons, it was found to commence as one or more white patches on the retina. As it grows it advances into the interior of the ball, causing detachment and atrophy of the retina as it proceeds. It may be recognized with the ophthalmoscope by the new vessels which appear on its surface and which are quite unlike those of the retina in their distribution. As the tumor grows the intraocular tension increases, the pupil is enlarged, the ball becomes painful, and, in short, glaucoma is developed. In the meantime, the glioma has probably been traveling backward along the optic nerve, and, if not interrupted, will soon reach the brain. Death follows usually from intracranial tumor. If the case is seen early enough, there is a chance to save life by enucleation of the ball, and by cutting off the optic nerve at the very apex of the orbit, with a tenotome. If the nerve is decidedly affected, however, the growth soon recurs, and death happens at an early date.

EMBOLISM of the central artery of the retina is one of the curiosities of ophthalmology, and many cases have been described under this name which were probably merely neuro-retinitis. The original case described by Von Graefe

was the subject of disease of the heart when attacked by sudden blindness in one eye. The ophthalmoscope showed a white but transparent retina, and both arteries and veins very much contracted, the former scarcely visible. In a couple of weeks, after some degree of collateral circulation became established, the veins were fuller but their contents irregularly disposed, and the retina had become opaque from cell proliferation, except at the fovea, which was bright red. Nerve and retina finally atrophied, but the diagnosis of embolism was confirmed subsequently by a post-mortem examination.

CHAPTER XIII.

DISORDERS OF THE EYEBALL.

GLAUCOMA is a term used to denote those morbid conditions of the eye which are produced by an increase in the quantity of its fluid contents. In about one-third of all cases of the disease the symptoms approach so insidiously as scarcely to be noticed at first. This condition is known as *chronic glaucoma* (glaucoma simplex). The patient, who is probably past middle age, finds that his presbyopia is rapidly increasing, that he is obliged to have his glasses frequently changed for stronger ones, and that his distant vision also is becoming impaired. This probably leads him to seek medical advice. An examination discloses the fact that the individual, who perhaps was previously emmetropic, has become somewhat myopic, and that the range of his accommodation is less than he should be entitled to, at his age. If the eyeball be felt through the closed lids with the tips of the forefingers it will be found to be harder than is natural. This increased tension may, according to the stage of the disease, be of different degrees, and these are usually designated by the signs + T 1, + T 2, + T 3, the last being as hard as bone. A doubtful increase would be written + T 1 ?. Normal tension is written T N, diminished tension — T 1, etc. Both eyes are usually affected, but in different degrees, so that

one may be compared with the other. Owing to the compression of the ciliary nerves the iris acts sluggishly, the pupil responds but slowly to the influence of light, the ciliary muscle becomes more or less inactive, affecting the accommodation, as before stated, and the sensitiveness of the cornea is impaired, so that it may often be touched without being felt by the patient. Compression of the anterior perforating veins, as they run obliquely through the sclerotic near the cornea, causes the blood to accumulate in them, and they may be seen swollen and tortuous, coursing over the front of the sclerotic under the conjunctiva. The visual field becomes contracted. The limitation commences above or below and usually at the inner side. Afterward, however, it encroaches on all parts of the periphery, and approaching the centre finally produces blindness. At any stage of the disease the color fields are less affected than in atrophy.

Examination of the fundus with the ophthalmoscope shows that the lamina cribrosa has been pushed outward by the intraocular pressure, and that the optic disk has become cup shaped. When this cup is fully formed the entire disk is sunken, the edge is marked by a sharp, white ring, which overhangs the receding walls of the cavity, the nerve fibres have disappeared and the retinal vessels, pressed close against the sides of the excavation, often vanish after passing over its edge, to reappear upon its floor. The depth of the cavity can be measured by the difference of the lenses with which the floor and the edge can be seen (page 225). This condition is liable to simulation by a physiological cup, especially if the nerve has undergone atrophy. But the

glaucomatous condition may usually be recognized by the fact that in it the edge of the cavity is limited by the scleral ring only. The physiological cup is apt to be much the same in both eyes, but in glaucoma one eye is more advanced than the other. In atrophy, too, the contraction of the visual field generally begins on the temporal side. Another ophthalmoscopic appearance is the pulsation of the retinal arteries. This also is due to the increased intra-ocular tension (page 89), and if not at first visible may be brought out by slight pressure on the ball with the tip of the finger. The retinal veins are usually somewhat distended and tortuous, and the arteries contracted. There is no pain, the loss of vision is gradual, and several years may elapse before blindness supervenes.

Acute glaucoma attacks suddenly, with pain, impairment of the sight, ocular congestion, and rapid increase of the tension. The pain is due to the compression of the ciliary nerves, and is felt not only in the eyeball, but is reflected to the branches of the first division of the fifth nerve. Hence it radiates down the nose, over the forehead, and may even involve the whole side of the head. The pupil becomes dilated and fixed. The impairment of sight may amount even to temporary blindness, and is owing partly to compression of the optic nerve and retina, and partly to a lessened transparency of the cornea. The vessels of the conjunctiva around the cornea are congested to a greater or less degree. The rapid increase of tension pushes the lens and iris forward, and diminishes the depth of the anterior chamber. The acute attack may supervene upon the chronic condition, or it may arise in an eye which was before in

apparently good health. The symptoms may, in short, be said to be an aggravation of those of the chronic condition, accompanied by pain and congestion. The paroxysm may subside and leave the vision but little impaired. There will remain, however, in some degree, the symptoms which characterize the chronic affection. New attacks supervene, each leaving the eye in a worse condition than before. The patient sees colored halos around lights of all kinds. The cornea becomes roughened and dotted with opaque spots, so that the cupped optic disk can no longer be seen. In the course of some weeks the eye becomes totally blind, and of a bony hardness (*absolute glaucoma*). Cataract often forms. In some cases the cornea breaks down, and the globe finally atrophies. In occasional instances the onset of the disease is so overwhelming that a few days, or it may be hours only, intervene between perfect health and utter blindness. This has been called *fulminating* glaucoma.

Donders' theory, that the disease is owing to a neurosis of the fifth nerve resulting in a hypersecretion of the intraocular humors probably explains the symptoms of glaucoma better than any other. Either as a cause, effect or accompaniment of the malady, there is also, however, a certain amount of inflammatory change in the choroid. The mechanical theory, which makes the affection depend solely on an obstruction of the natural outlets to the anterior chamber, through the canal of Schlemm, and the trabecular spaces of Fontana, will not bear investigation, although such a condition no doubt frequently supervenes in the course of the disease. The affection rarely occurs in individuals under thirty years of age, and most frequently

in hypermetropic eyes. Women are more liable to it than men. The use of atropia appears in some cases to be an exciting cause. So also are anxiety and loss of sleep. Neuralgia of the fifth nerve, some retinal hemorrhages, and morbid adhesions or entanglements which keep up irritation of the iris are liable to produce the glaucomatous condition.

The treatment of the disease consists principally in the performance of iridectomy. Some chronic cases appear to be temporarily relieved by the use of a collyrium of sulphate of eserine, gr. ij ad f℥j, which diminishes to some extent the intraocular tension. Acute pain sometimes requires the administration of morphia. But as a general rule the sooner an iridectomy is done the better. The operation should be performed in the manner described as proper to a preliminary iridectomy in cataract (page 202). The piece removed should include about one-sixth of the circumference, should be cut as close to the periphery as possible, and great care must be taken to free the remaining iris from the corners of the wound. The principal indication for the performance of the operation is increased intraocular tension, and in cases where the diagnosis of glaucoma is based on the appearance of the disk only, iridectomy is useless. Precisely how the operation acts in the cure is at present conjectural. In very acute cases the immediate performance of iridectomy generally results in complete cure. In subacute cases, with limitation of the visual field, slow improvement follows. In chronic conditions preservation of the remaining sight is to be considered a good result. If in any instance recovery be not

permanent, and the glaucomatous condition returns, a second iridectomy may be done, opposite the first. The patient soon learns to cover the coloboma with the lower lid, and it is not annoying. If, as sometimes happens, the glaucomatous process is hastened in the other eye, by an operation on the one first affected, the second eye should be operated on without delay. It occasionally happens, in chronic glaucoma, that the disease is merely aggravated by the operation. Tension increases, the anterior chamber is obliterated, etc. This is called *malignant* glaucoma, and for its relief Weber recommended that in about a fortnight after the iridectomy the sclerotic be punctured in the horizontal meridian, by means of a keratome, and a small amount of the vitreous be squeezed out.

As a substitute for iridectomy, the operation of *sclerotomy* has been frequently performed. The linear knife is introduced one millimeter behind the edge of the cornea, on the outer side, above the median line, carried in front of the iris and brought out horizontally opposite to the point of entrance. The incision is made slowly upward, close in front of and parallel to the plane of the iris. A bridge of uncut scleral tissue is left at the summit of the incision. A weak solution of eserine is used afterward, to insure contraction of the pupil. De Wecker claims that this operation is preferable to iridectomy in chronic or in absolute glaucoma and in glaucoma with a hemorrhagic tendency.

After iridectomy or sclerotomy the wound sometimes closes imperfectly and a *cystoid cicatrix* is formed. The cicatricial tissue is so loose that the aqueous humor filters through and collects in a small blister under the conjunc-

tiva. The irritation thus occasioned may give rise to new tissue formation and closer union of the wound, or it may run on to purulent choroiditis and destruction of the eye. The blister should be pricked, to allow it to collapse, and a compress and bandage applied to the eye. This procedure may be repeated several times, if necessary.

PHTHISIS of the eyeball has already been mentioned in connection with the subject of irido-choroiditis. A rare variety sometimes follows injury of the globe. It is characterized by photophobia, lachrymation, pain, marked diminution of the intraocular tension, and some pericorneal hyperæmia. The attacks are paroxysmal and accompanied by impairment of the vision. The disease may end in recovery, or in some degree of atrophy of the organ.

Most of the INJURIES which may happen to the eyeball have already been mentioned in connection with the discussion of the diseases and injuries to which the several parts are liable. Contusions may expend their force upon any of the coats of the eye, and their effects must be carefully studied by focal illumination. Blood effused into the anterior chamber calls for no special treatment, and is generally absorbed in a few days, if there is no more profound injury. If complicated with traumatic cataract and prolonged congestion and irritability of the eye, complete relief may often be obtained by the performance of an iridectomy. If rupture of the sclerotic has taken place, it is usually in the ciliary region, and is often accompanied by extrusion of the lens or the vitreous. Small *foreign bodies* often pass into the eye and remain there beyond the possibility of removal. The great danger to be feared in all cases of severe

injury is the possibility of loss of the healthy eye through the occurrence of *sympathetic ophthalmia*. If this inflammation once commences it cannot be stopped by treatment, and it is, therefore, of the greatest importance that it should be avoided altogether. The rules which should govern the surgeon in connection with this subject are as follow: 1. So long as sight, other than mere light perception, remains in the injured eye, it should not be removed. 2. If an injured eye is blind, and remains or becomes sensitive, or congested, or contains a foreign body, or chalky lens, it is best to enucleate at once. 3. Even if such a blind eye is perfectly quiescent, it is safest to remove it; but at the slightest sign of sympathetic affection of the other eye, enucleation of the injured one is imperative. 4. If retention of the blind eye is particularly desirable, on account of its healthy external appearance, enucleation may be deferred, provided the patient can be kept under observation.

The removal of an eyeball which has collapsed after injury, or which has undergone purulent choroiditis and has involved the tissues of the orbit in the inflammation, is often attended with considerable difficulty. In such cases the remains of the ball must be dissected out of its socket, care being taken to leave as much of the conjunctiva and of the muscles and tissues of the orbit as possible.

Among the foreign bodies which are liable to enter the eye, may be mentioned the *cysticercus*. Such an event is, however, very rare in this country. The entozoon consists of a somewhat translucent, whitish cyst, to which is attached a retractile neck and head. By means of this head the parasite attaches itself to the tissues. If it appears in the

anterior chamber the cysticerus is readily recognized, but it is more frequently first noticed under the retina, of which it causes a detachment. If it breaks through into the vitreous there is so much accompanying inflammation of the tissues and opacity of the refractive media, that diagnosis becomes difficult. The presence of such a foreign body must, if it remains, end in the destruction of the eye. From the anterior chamber its removal is easy, but if the parasite is in the vitreous, the ingenuity of the surgeon will be taxed to compass its extraction without destroying the visual organ.

CHAPTER XIV.

DISEASES OF THE ORBIT.

ORBITAL CELLULITIS is a disorder of much gravity, and not infrequently menaces the life of the individual. In most cases, all the tissues of the orbit are more or less involved in the inflammation. The malady commences with severe pain in and around the eye, and red and swollen lids. Fever sets in, the conjunctiva becomes chemosed, but there is no mucus nor purulent secretion. The ball is soon pushed forward in the line of the axis of the orbit, sometimes to such an extent that the lids cannot be closed, and the cornea ulcerates. The motions of the ball are at the same time impeded in all directions, and the least pressure upon it in an attempt to push it back into the orbit gives rise to exquisite pain. The optic nerve often becomes affected with subsequent atrophy of the disk. Pus forms in the dephts of the orbit, generally accompanied by rigors, makes its way to the surface, and discharges either through the skin or conjunctiva. Finally, panophthalmitis may set in, or the inflammation may extend to the membranes of the brain, with the production of cerebral symptoms. The disease is usually very acute and passes through all its stages in a few weeks, but cases have been known to become chronic, and to last for months.

In certain states of the system the disease may arise

from injuries of any kind to the tissues of the orbit, from extension of inflammatory action from adjoining parts, or as an incident in other diseases, such as erysipelas, puerperal fever, smallpox, meningitis, etc.

Periostitis may affect any portion of the orbital walls, and is always accompanied by a greater or less amount of cellulitis, which so veils the original disease that it is sometimes difficult of detection. The cellulitis, however, is to some extent localized, and this tendency to localization is greater, the more chronic the malady. Hence some point may usually be found just within the edge of the orbit, where pressure with the finger-tip procures evidence of especial sensitiveness and swelling. The eyeball, too, instead of being forced directly forward, in the line of the orbital axis, is pressed to one side, and the interference with its movements is in one direction mostly. According to the violence of the disease the suppuration may be limited to the spot first inflamed, or it may involve all the tissues of the orbit. In any case the denuded bone may be felt with a probe after the abscess has opened. The disorder may arise from injury or from continuity of tissue with the inflamed periosteum of adjoining cavities. Chronic cases arise mostly from syphilis. The periostitis may result in disease of the bone, which may endanger the life of the individual, through meningitis or abscess of the brain.

The treatment of cellulitis and periostitis must be directed, in the acute stage, to allaying the violence of the inflammation by means of iced compresses, leeches to the temple, cathartics, etc. If suppuration is inevitable, how-

ever, warm poultices must be applied, and the abscess opened at the earliest possible moment. If fluctuation be discovered externally, a free incision should be made and a drainage tube introduced. If the condition is doubtful, and the suffering great, a linear knife may be inserted flatwise between the ball and the upper wall of the orbit, the entire length of the blade, and if pus be obtained the incision should be enlarged, and a drainage tube introduced. It is especially important to make an early opening in cases of periostitis, in order to prevent, if possible, extensive baring of the bone. Foreign bodies should, of course, be removed if they are encountered by the knife or probe.

Caries or necrosis of the orbital walls may result from periostitis, or they may arise from injury, in such depraved conditions of the system as scrofula or syphilis. The most exposed portion of the orbit, viz., the margin, is most likely to become diseased. The loose tissue of the lids gives the first evidence of the inflammation, the eye is nearly or entirely closed by œdematous swelling, the conjunctiva is inflamed, an abscess soon forms, and points in the upper or lower lid, generally near the outer canthus. If the abscess be opened an unhealthy discharge takes place, the opening shows no signs of healing, becomes retracted, and adherent to the periosteum, and the use of the probe discloses the presence of diseased bone. After a while the subcutaneous fascia becomes contracted, and eversion of the lid (ectropium) takes place. The abscess should be opened as early as possible, a drainage tube introduced, and dead bone removed as soon as it becomes loose. The treatment of ectropium has been mentioned in a previous chapter.

Inflammation of the capsule of Tenon may supervene upon the performance of the operation for strabismus, as a rheumatic affection, from cold, or as an accompaniment to violent inflammatory conditions of the ball. It produces congestion and chemosis of the conjunctiva, pain, some swelling of the lids, and interference with the motions of the eye. If these symptoms arise without intraocular cause, they may be attributed to rheumatic inflammation. Severe pain is best relieved by leeches to the temple and warm fomentations. The affection is disposed to be obstinate, and often lasts a couple of months. Inflammation from traumatic cause is best subdued by the application of cold compresses.

INJURIES of the orbit may arise from the penetration of foreign bodies of all kinds, or from contusions. Owing to the thinness of the bony walls these are liable to fracture from a moderate degree of force, if applied directly. Hence, occurs the danger to the brain and to life from the penetration of instruments or weapons which would otherwise seem to be trivial. Fractures extending into the frontal sinus, or ethmoid cells, produce emphysema of the lids. All fractures require perfect rest. Inflammatory symptoms should be moderated by the application of cold, leeching, and low diet. Foreign bodies must be removed as soon as they can be found, but small objects, like bird shot, should not be searched for to the detriment of the delicate structures of the orbit. Contusions often produce considerable effusion of blood, pushing the eye partially out of its socket and infiltrating the tissue of the lids and beneath the conjunctiva. The vision and the motions of the eyeball are

more or less impaired. Absorption is hastened by the use of the pressure bandage and cooling lotions. The eyeball is sometimes pushed out between the lids by the entrance of a foreign body into the orbit. After the removal of the intruding object, the ball should be replaced and a retaining bandage applied.

TUMORS of the orbit, if superficial, are generally fibrous, fatty, bony or vascular. Lipomata may usually be seen beneath the palpebral fold of the conjunctiva, by everting the lid. Fibromata of small size are apt to grow near the edge of the orbit and are firm to the touch. Osteomata are very hard. Angiomata are formed by the expansion of old or the formation of new vessels. Telangiectasiæ or nævi are the commonest form of this class, and they grow backward from the skin of the lids into the cellular tissue of the orbit. Aneurism by anastomosis occurs mostly in little children. The skin is raised by a tortuous mass of vessels which may be emptied by compression and in which the movements of the blood may be felt. Compression of the carotid has little effect on the size of the tumor, which is increased, however, by anything which produces congestion of the head. These are all of slow and painless growth and unaccompanied by inflammatory symptoms.

Deep-seated tumors may be either benign or malignant. They may arise in the orbit, or may penetrate its walls from the adjacent cavities, or from the eyeball itself. Commencing exophthalmus usually gives the first indication of their presence. If the growth of the tumor is slow, the distention of the lids may keep pace with the protrusion of the ball for a considerable time. But sometimes the globe

is pushed out on to the cheek, the lids everted, the conjunctiva chemosed, and the cornea ulcerated. If the tumor is situated near the roof of the orbit there is always ptosis. The extent to which vision is impaired depends on whether the optic nerve is involved in the tumor. Ophthalmoscopic examination of the affected eye should always be made. Optic neuritis is usually followed by atrophy of the disk. If there is a choked disk in the other eye, it is tolerably certain that the tumor involves the brain. The diagnosis of the nature of the growth must be governed to a great extent by general considerations. If the disease is malignant its progress is apt to be rapid, the pain is great, and the general health soon suffers. Limitation of the movements of the eye, with diplopia, appear as almost the earliest symptoms, and if the growth can be seen or felt, its boundaries are ill defined and the skin is closely adherent.

Treatment.—Bony tumors sometimes yield to iodide of potash, but if they do not, resection is hazardous, for it is often uncertain how far the disease extends. Vascular tumors may be cured by subcutaneous ligature. If too large to allow constriction by a single thread, others may be used at the same time, or in subsequent operations. In the removal of other growths the eyeball may usually be saved, if the tumor does not penetrate too deeply. Such muscles as are in the way may be divided, and after the removal of the tumor, be again united by sutures. If the periosteum is involved, it must be loosened from the bone, back to the apex of the orbit, where it may be cut off close with curved scissors, and the entire orbital contents removed.

ANEURISM of the ophthalmic artery is rare, although pulsating tumors of the orbit are not uncommon. Together with the usual symptoms of aneurism, such as pulsation and bruit, there is also much pain, exophthalmus and dilatation of the superficial vessels. The tumor may be made smaller by pressure, and the pulsation ceases upon constriction of the carotid. False aneurism, the result of injury, or of spontaneous rupture of degenerated vessels, has the same symptoms as the true. In both cases the remedy is ligation of the common carotid artery.

EXOPHTHALMIC GOITRE is characterized by moderate enlargement of the thyroid gland, frequent pulse, cardiac hypertrophy, dilatation, easily excited palpitation and exophthalmus. Both eyes are affected, sometimes, to such an extent that the cornea ulcerates and loss of the visual organ is threatened. Defective innervation of the ocular muscles is an early symptom, and shows itself in failure, or sluggish action of the upper lid in following the vertical movements of the eye, also in epiphora, in infrequent winking, or in diplopia. The pupil is usually dilated. The heart symptoms may, after a while, ameliorate, and the patient recover, or the digestion may fail, the individual become exsanguinous, and death take place. The disease is supposed to be owing to some affection of the central sympathetic system. Treatment is limited to relieving the heart symptoms, by means of digitalis, etc., to improving the condition of the blood by the administration of iron, and the general nutrition by suitable measures. Galvanization of the cervical sympathetic and the administration of iodine have seemed to do good in some cases. Ulceration of the cornea is to be treated as previously directed (page 159).

ABSCESS OF THE FRONTAL SINUS may follow an injury, or result from catarrh. No doubt such a condition often occurs, but as the discharge takes place through the natural passages into the nose, no inconvenience beyond local pain and sense of fullness is experienced. When the outlet becomes obstructed, however, the secretion accumulates and displaces the bony walls of the cavity. The thinnest portion, and first to yield, is that which makes part of the roof of the orbit. This becoming distended pushes the eyeball downward, and outward, and appears as a tumor at the upper and inner angle of the orbit. The skin finally reddens, fluctuation becomes evident, and the abscess bursts, or is opened by the surgeon. The introduction of a probe now makes it evident that the frontal sinus is affected. The disease is usually very slow in its progress, the eye becomes settled in its new position and its motion somewhat impaired. Some degree of ptosis accompanies the exophthalmus. After the relation of the parts has been examined, by means of the probe, it is best to slit up the floor of the sinus in an outward direction, just behind the edge of the orbit, with a strong knife. The contents of the abscess should then be evacuated, and the cavity washed out. The point of a curved bistoury may be introduced to open the passage into the nose, a finger in the nostril serving as a guide, and a piece of lead wire inserted and left in the opening for several weeks. The sinus should be syringed several times daily with a half-grain solution of nitrate of silver. When the discharge has mostly disappeared and the connection with the nose appears to be established, the wire may be withdrawn, and the wound allowed to heal.

INDEX.

C.

H.

I.

J.

K.

L.

M.

N.

O.

T.

U.

V.

W.

X.

Z.